



Vera C. Rubin Observatory  
Data Management

# Data Management System Design

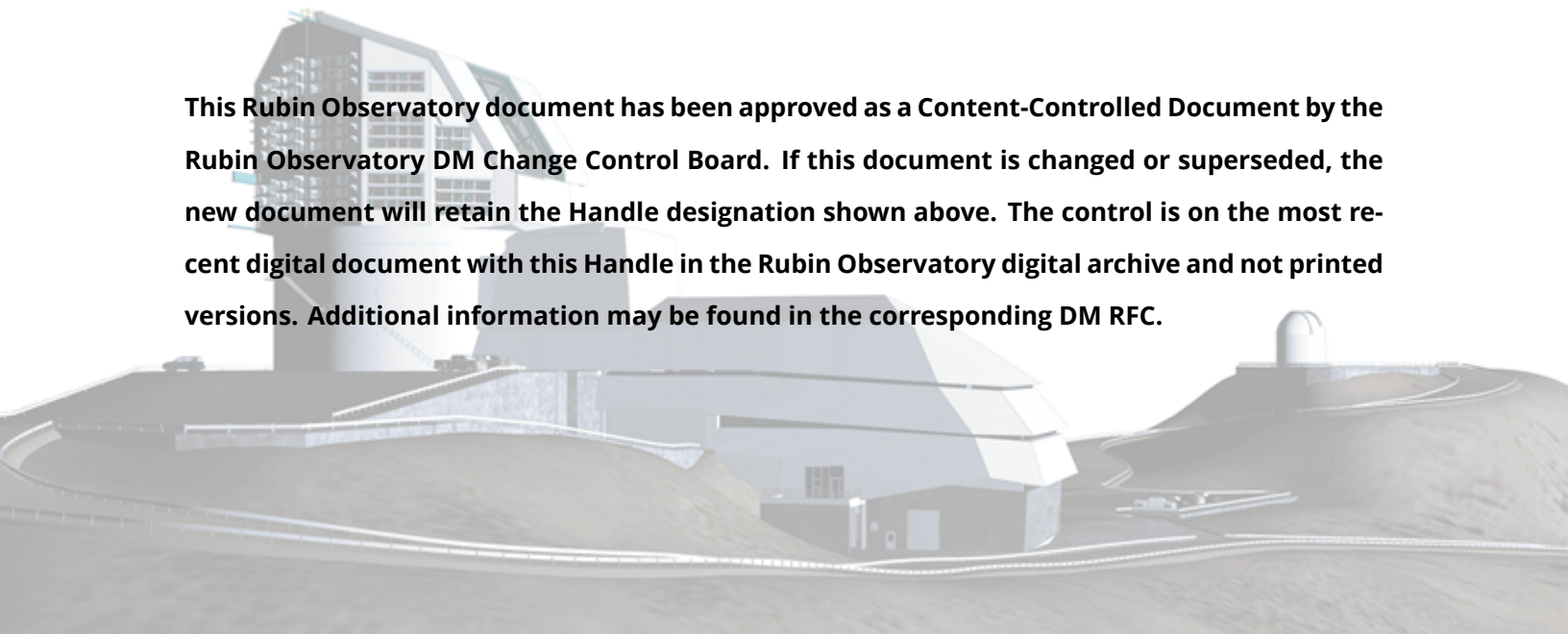
Kian-Tat Lim, James F. Bosch, Gregory P. Dubois-Felsmann,  
Tim Jenness, Jeffrey P. Kantor, William O'Mullane,  
Donald L. Petravick, Gabriele Comoretto, and  
Rubin Observatory Data Management Leadership Team

LDM-148

<https://doi.org/10.71929/rubin/2587850>

Latest Revision: 2020-08-20

This Rubin Observatory document has been approved as a Content-Controlled Document by the Rubin Observatory DM Change Control Board. If this document is changed or superseded, the new document will retain the Handle designation shown above. The control is on the most recent digital document with this Handle in the Rubin Observatory digital archive and not printed versions. Additional information may be found in the corresponding DM RFC.



## Abstract

The Rubin Observatory LSST Data Management System (DMS) is a set of services employing a variety of software components running on computational and networking infrastructure that combine to deliver science data products to the observatory's users and support observatory operations. This document describes the components, their service instances, and their deployment environments as well as the interfaces among them, the rest of the LSST system, and the outside world.

## Change Record

| Version | Date       | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Owner name                                         |
|---------|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|
| 2       | 2011-08-09 | Copied from MREFC Proposal into LDM-148 handle, reformatted                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Robert McKercher                                   |
| 3       | 2011-08-15 | Updated for Preliminary Design Review                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Tim Axelrod, K-T Lim, Mike Freemon, Jeffrey Kantor |
| 4       | 2013-10-09 | Updated for Final Design Review                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Mario Juric, K-T Lim, Jeffrey Kantor               |
| 5.0     | 2017-07-04 | Rewritten for Construction and Operations. Approved in RFC-358.                                                                                                                                                                                                                                                                                                                                                                                                                                                  | K-T Lim                                            |
| 6.0     | 2018-07-12 | Add Observatory Operations Data and Planned Observation Publishing Services; synchronize terminology with new product tree, LDM-129, and LDM-230. Approved in RFC-456.                                                                                                                                                                                                                                                                                                                                           | K-T Lim                                            |
| 6.1     | 2019-01-23 | Add historical note on DMCS. Approved in RFC-530.                                                                                                                                                                                                                                                                                                                                                                                                                                                                | K-T Lim                                            |
| 6.2     | 2019-01-30 | Add text about outbound bandwidths and modify near-realtime dataflow figure. Approved in RFC-538.                                                                                                                                                                                                                                                                                                                                                                                                                | K-T Lim                                            |
| 6.3     | 2019-05-29 | Add service levels for enclaves. Approved in RFC-581.                                                                                                                                                                                                                                                                                                                                                                                                                                                            | K-T Lim                                            |
| 7.0     | 2019-07-17 | Synchronize with product tree and add LSE-400. Approved in RFC-614.                                                                                                                                                                                                                                                                                                                                                                                                                                              | K-T Lim                                            |
| 8.0     | 2020-08-19 | Add Rubin Observatory to initial uses of "LSST". Replace most of sizing section with DMTN-135 cite. Add data flow subsection. Remove crosstalk correction from DAQ. Add references to LDM-151 for Science Payloads. Terminology changes: US Data Facility for NCSA, Solar System for MOPS, OCPS for OCS Driven Batch, Calibration Products for Database, Notebook for JupyterLab. Update interfaces for Prompt Services. Remove DMCS as internal component. Fix relationship of VO to IVOA. Approved in RFC-708. | K-T Lim                                            |
| 8.1     | 2020-08-20 | Clarifications from Ops.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | K-T Lim                                            |

*Continued on next page*

| Version | Date       | Description                                                                     | Owner name |
|---------|------------|---------------------------------------------------------------------------------|------------|
| 8.1.1   | 2025-09-09 | Add DOI 10.71929/rubin/2587850. Formal date has not been changed on title page. | T. Jenness |

*Document curator:* Kian-Tat Lim

*Document source location:* <https://github.com/lsst/LDM-148>

## Contents

|          |                                           |           |
|----------|-------------------------------------------|-----------|
| <b>1</b> | <b>Introduction</b>                       | <b>1</b>  |
| <b>2</b> | <b>Summary Concept of Operations</b>      | <b>2</b>  |
| 2.1      | Data Flow . . . . .                       | 4         |
| <b>3</b> | <b>Sizing</b>                             | <b>5</b>  |
| <b>4</b> | <b>Component Overview</b>                 | <b>7</b>  |
| <b>5</b> | <b>Prompt Base Enclave</b>                | <b>14</b> |
| 5.1      | Service Descriptions . . . . .            | 17        |
| 5.1.1    | Archiving . . . . .                       | 17        |
| 5.1.2    | Planned Observation Publication . . . . . | 18        |
| 5.1.3    | Prompt Processing Ingest . . . . .        | 18        |
| 5.1.4    | Observatory Operations Data . . . . .     | 19        |
| 5.1.5    | OCS Controlled Pipeline . . . . .         | 19        |
| 5.1.6    | Telemetry Gateway . . . . .               | 19        |
| 5.2      | Interfaces . . . . .                      | 20        |
| <b>6</b> | <b>Prompt US Enclave</b>                  | <b>21</b> |
| 6.1      | Service Descriptions . . . . .            | 22        |
| 6.1.1    | Prompt Processing . . . . .               | 22        |
| 6.1.2    | Alert Distribution . . . . .              | 22        |
| 6.1.3    | Prompt Quality Control . . . . .          | 23        |
| 6.2      | Interfaces . . . . .                      | 23        |
| <b>7</b> | <b>Offline Production Enclave</b>         | <b>23</b> |
| 7.1      | Service Descriptions . . . . .            | 24        |
| 7.1.1    | Batch Production . . . . .                | 24        |
| 7.1.2    | Offline Quality Control . . . . .         | 26        |
| 7.1.3    | Bulk Distribution . . . . .               | 26        |

|           |                                                        |           |
|-----------|--------------------------------------------------------|-----------|
| 7.2       | Interfaces . . . . .                                   | 27        |
| <b>8</b>  | <b>Data Access Centers</b>                             | <b>27</b> |
| 8.1       | Service Descriptions . . . . .                         | 28        |
| 8.1.1     | LSST Science Platform DAC instances . . . . .          | 28        |
| 8.2       | Interfaces . . . . .                                   | 29        |
| <b>9</b>  | <b>Commissioning Cluster</b>                           | <b>29</b> |
| 9.1       | Service Description . . . . .                          | 30        |
| 9.1.1     | LSST Science Platform Commissioning instance . . . . . | 30        |
| 9.2       | Interfaces . . . . .                                   | 30        |
| <b>10</b> | <b>Backbone Services</b>                               | <b>30</b> |
| 10.1      | Service Descriptions . . . . .                         | 31        |
| 10.1.1    | DBB Ingest/Metadata Management . . . . .               | 32        |
| 10.1.2    | DBB Lifetime Management . . . . .                      | 32        |
| 10.1.3    | DBB Transport/Replication/Backup . . . . .             | 32        |
| 10.1.4    | DBB Storage . . . . .                                  | 32        |
| 10.2      | Interfaces . . . . .                                   | 32        |
| <b>11</b> | <b>Software Components</b>                             | <b>33</b> |
| 11.1      | Science Payloads . . . . .                             | 33        |
| 11.1.1    | Alert Production Payload . . . . .                     | 33        |
| 11.1.2    | Calibration Software . . . . .                         | 33        |
| 11.1.3    | Data Release Production Payload . . . . .              | 34        |
| 11.1.4    | Solar System and Forced Photometry Payload . . . . .   | 34        |
| 11.1.5    | Special Programs Productions Payload . . . . .         | 34        |
| 11.1.6    | Template Generation Payload . . . . .                  | 34        |
| 11.2      | SUIT . . . . .                                         | 34        |
| 11.3      | Supporting Software . . . . .                          | 35        |
| 11.3.1    | Science Pipelines Libraries . . . . .                  | 35        |
| 11.3.2    | Distributed Database (Qserv) . . . . .                 | 35        |

|                                                                    |           |
|--------------------------------------------------------------------|-----------|
| 11.3.3 ADQL Translator . . . . .                                   | 35        |
| 11.3.4 Image/Cutout Server . . . . .                               | 35        |
| 11.4 Middleware . . . . .                                          | 36        |
| 11.4.1 Data Butler Access Client . . . . .                         | 36        |
| 11.4.2 Task Framework . . . . .                                    | 36        |
| <b>12 Infrastructure Services</b>                                  | <b>37</b> |
| 12.1 Service Descriptions . . . . .                                | 37        |
| 12.1.1 Managed Database . . . . .                                  | 37        |
| 12.1.2 Batch Processing . . . . .                                  | 37        |
| 12.1.3 Containerized Application Management . . . . .              | 38        |
| 12.1.4 IT Security . . . . .                                       | 38        |
| 12.1.5 Identity Management . . . . .                               | 39        |
| 12.1.6 ITC Provisioning and Management . . . . .                   | 39        |
| 12.1.7 Service Management/Monitoring . . . . .                     | 39        |
| 12.2 Interfaces . . . . .                                          | 39        |
| <b>13 NCSA Development and Integration Enclave</b>                 | <b>40</b> |
| 13.1 Service Descriptions . . . . .                                | 40        |
| 13.1.1 LSST Science Platform Science Validation instance . . . . . | 40        |
| 13.1.2 Developer Services . . . . .                                | 40        |
| 13.2 Interfaces . . . . .                                          | 41        |
| <b>14 Design and Implementation Standards</b>                      | <b>41</b> |
| 14.1 HTTPS Protocol . . . . .                                      | 41        |
| <b>15 Appendix: Traceability</b>                                   | <b>42</b> |
| 15.1 Requirement to Component Traceability . . . . .               | 42        |
| 15.2 Component to Requirement Traceability . . . . .               | 60        |
| <b>16 References</b>                                               | <b>98</b> |

# Data Management System Design

## 1 Introduction

The purpose of the Rubin Observatory LSST Data Management System (DMS) is to deliver science data products to the observatory's users and to support observatory operations. The DMS is a set of services employing a variety of software components running on computational and networking infrastructure. The DMS is constructed by the DM subsystem in the NSF MREFC project; in the Operations era, it is operated by a combination of the Data Production, Science Operations, and Observatory Operations departments.

The data products to be delivered are defined and described in the *Data Products Definition Document* [LSE-163]. These are divided into three major categories.

One category of data products is generated on a nightly or daily cadence and comprises raw, processed/calibrated, and difference images as well as alerts of transient, Solar System, and variable objects detected from the images, published within 60 seconds, and recorded in searchable catalogs. These data products can be considered "online", as they are driven primarily by the observing cadence of the observatory. This category of Prompt data products has historically been referred to as "Level 1". These products are intended to enable detection and follow-up of time-sensitive time-domain events.

A second category of data products is generated on an annual cadence and represents a complete reprocessing of the set of images taken to date to generate astronomical catalogs containing measurements and characterization of tens of billions of stars and galaxies with high and uniform astrometric and photometric accuracy. As part of this reprocessing, all of the first category of data products is regenerated, often using more accurate algorithms. This category also includes other data products such as calibration products and templates that are generated in an "offline" mode, not directly tied to the observing cadence. This category of Data Release data products has historically been referred to as "Level 2", including the regenerated data products from the first category.

The third category of data products is not generated by the LSST DMS but is instead generated, created, or imported by science users for their own science goals. These products derive value from their close association with or derivation from other LSST data products. The DMS is

responsible for providing facilities, services, and software for their generation and storage. This category of User Generated data products has historically been referred to as “Level 3”.

Data products are delivered to science users through Data Access Centers (DACs). In addition, streams of near-realtime alerts and planned observations are provided. Each LSST data product has associated metadata providing provenance and quality metrics and tracing it to relevant calibration information in the archive. The DACs are composed of modest but significant computational, storage, networking, and other resources intended for use as a flexible, multi-tenant environment for professional astronomers with LSST data rights to retrieve, manipulate, and annotate LSST data products in order to perform scientific discovery and inquiry.

The first section of this document describes how the DMS components work together to generate and distribute the data products. The next section describes how the size of the DMS computing environments was estimated. Subsequent sections describe the individual components of the DMS in more detail, including their interfaces with each other, with other LSST subsystems, and with the outside world.

## 2 Summary Concept of Operations

The principal functions of the DMS are to:

- Process the incoming stream of images generated by the camera system during observing by archiving raw images, generating transient alerts, and updating difference source and object catalogs.
- Periodically (at least annually) process the accumulated survey data to provide a uniform photometric and astrometric calibration, measure the properties of fainter objects, and characterize the time-dependent behavior of objects. The results of such a processing run form a data release (DR), which is a static, self-consistent data set for use in performing scientific analysis of LSST data and publication of the results. All data releases are archived for the entire operational life of the LSST archive.
- Periodically create new calibration data products, such as bias frames and flat fields, to be used by the other processing functions.
- Make all LSST data available through an interface that utilizes, to the maximum practical

extent, community-based standards such as those being developed by the International Virtual Observatory Alliance (IVOA) for the Virtual Observatory (VO). Provide enough processing, storage, and network bandwidth to enable user analysis of the data without petabyte-scale data transfers.

The latency requirements for alerts determine several aspects of the DMS design and overall cost. An alert is triggered by an unexpected excursion in brightness of a known object or the appearance of a previously undetected object such as a supernova or a gamma ray burst. The astrophysical time scale of some of these events may warrant rapid follow-up by other telescopes. These excursions in brightness must be recognized by the pipeline, and the resulting alert data product sent on its way, within 60 seconds. This drives the DMS design in the decision to acquire high-bandwidth/high-reliability long-haul networking from the Summit at Cerro Pachon to the Base in La Serena and from Chile to the U.S. These networks allow the significant computational resources necessary for promptly processing incoming images to be located in cost-effective locations: the Base has far fewer limitations on power, cooling, and rack space capacity than the Summit, and placing the scientific processing at the US Data Facility allows for far greater flexibility in the allocation of resources to ensure that deadlines are met. Parallelizing the alert processing at the amplifier and CCD levels, where possible, also helps to minimize the latency to alert delivery.

The Data Release processing requires extensive computation, combining information from all images of an object in order to measure it as accurately as possible. A sophisticated workload and workflow management system and Task Framework are used to divide the processing into manageable units of work that can be assigned to available resources, including the dedicated processing clusters at the US Data Facility and Satellite Facility.

Calibration Products must be created and updated at cadences in between the Alert and Data Release periods. The stability of the system is expected to require daily, monthly, and annual calibration productions. The daily production must be synchronized with the observatory schedule, occurring after raw calibration frames have been taken but well before science observing is planned. This requirement necessitates the inclusion of a service that allows the Observatory Control System to trigger pipeline processing.

The DACs are a key component of the DMS, giving the community resources and an interface to interact with and utilize the LSST data products to perform science. An instance of the LSST Science Platform (LSP) is deployed in each DAC to support science users with its Portal,

Notebook, and Web API aspects. Substantial compute, storage, and storage bandwidth is devoted to ensuring that the LSP is responsive and allows for exploration of the vast LSST data products.

Underlying all of the above is a Data Backbone that provides storage, tracking, and replication for all LSST data products. The Data Backbone links the computing environments including the Data Access Centers, acting as the spine that supports them all.

## 2.1 Data Flow

Images (science and calibration) are taken on the mountain and stored in the camera image buffer (sized for a week or more). Images are copied by the camera software to the Camera Diagnostic Cluster (on the summit) for rapid analysis. Images may reside on that cluster for a short time. Images are also transferred to the Observatory Operations Data Service (OODS) for use by the OCS-Controlled Pipeline Service (OCPS), the Commissioning Cluster (in the base facility), and other Observatory systems such as the Active Optics System on the summit. They are expected to reside in the OODS for at least 30 days. At the time of readout, images are sent quickly to the US Data Facility (USDF) for Prompt Processing. A copy of the raw images is kept in the Base Facility in Chile as part of the Data Backbone, and an archival copy is also maintained in the Data Backbone at the US Data Facility. After a delay period agreed with NSF, DOE, SLAC, and AURA, the raw images are made available to all approved data rights holders. Access is at least from the US and Chilean Data Access Centers (DACs) via the LSST Science Platform and could also be from other Independent Data Access Centers (IDACs). During the 24 hours after readout, raw images are sent to the Satellite Data Facility at CC-IN2P3 both as a disaster recovery backup and to facilitate the Data Release Processing there at a later date. Processing may also be done at other international data facilities.

Information about the state of the Observatory (parts of which are sometimes referred to as image metadata) is collected from messages in the Observatory control network and transmitted via two mechanisms. The Header Service component of the Archiving service collects information required for the OCPS and Prompt Processing and creates FITS headers that are attached to the image pixels during export from the camera image buffer. Separately, the Engineering and Facility Database (EFD) collects all control messages and transports them via Kafka messaging to a replica at the US Data Facility, where they are aggregated and summarized for eventual use by the Calibration Products Production. The EFD data is made available to the US and Chilean DACs as well.

Alerts generated by the Alert Production payload in the Prompt Processing service are distributed as rapidly as possible by the Alert Distribution service. This is currently expected to be within 60 seconds after the image is read out from the camera in Chile.

Other data products, whether images or catalogs and whether Prompt or Data Release, are generated within the USDF or the Satellite Data Facility. They are archived in the Data Backbone at the USDF which then replicates them to the Base Facility in Chile. Staff have access to these data products through the LSST Science Platform Science Validation instance. After appropriate quality control, they are released to the US and Chilean Data Access Centers and made available to data rights holders via the LSST Science Platform.

### 3 Sizing

A fundamental question is how large the LSST Data Management System must be. To this end, an analytical model has been developed driven by input from the requirements specifications. Specifications from the science requirements and other subsystem designs, and the observing strategy, translate directly into numbers of detected sources and astronomical objects. These requirements are found in [4] with explanatory detail in [6]. Key input parameters include camera characteristics, the expected cadence of observations, the number of observed stars and galaxies expected per band, the processing operations per data element, the data transfer rates between and within processing locations, the ingest and query rates of input and output data, the alert generation rates, and latency and throughput requirements for all data products.

The model that estimates the compute and storage needed to generate and serve the data products is found in [13].

Communications requirements were developed and modeled for the data transfers and user query/response load, extrapolated from existing surveys and adjusted to LSST scale. These requirements are illustrated in Figure 1 for per-visit transfers. Peak bandwidths assume a 3 second budget for Summit to Base image transfer and a 5 second budget for international image transfer. The peak alert bandwidth assumes 40K alerts delivered in 15 seconds.

The Summit to Base and Base to NCSA network links have been significantly over-engineered for four main reasons: first, because the incremental costs of higher bandwidth once the link

has been provisioned at all have been small; second, to allow key functions, such as interfacing with the Camera Data System or performing image analysis and measurement to generate alerts, to be performed in appropriate locations; third, to increase reliability of the system; and fourth, to simplify certain components such as the Forwarders and Archivers that interface with or depend on the networks. A high-speed Base to NCSA link also enables Data Releases to be transferred south to the Chilean DAC over the network rather than through physical media, as originally planned, decoupling science from maintenance and upgrade activities to a greater extent.

The external bandwidth from NCSA to the community alert brokers is baselined at 10 Gbit/sec. Given an estimate of the peak alert bandwidth of up to 1.8 Gbit/sec [LDM-151], at least 5 community brokers can be supported with this allocation. Additional external outbound bandwidth is needed for NCSA to deliver results to science users from the US Data Access Center and to deliver bulk downloads to partners; this has been estimated as 52 Gbit/sec in LDM-141.

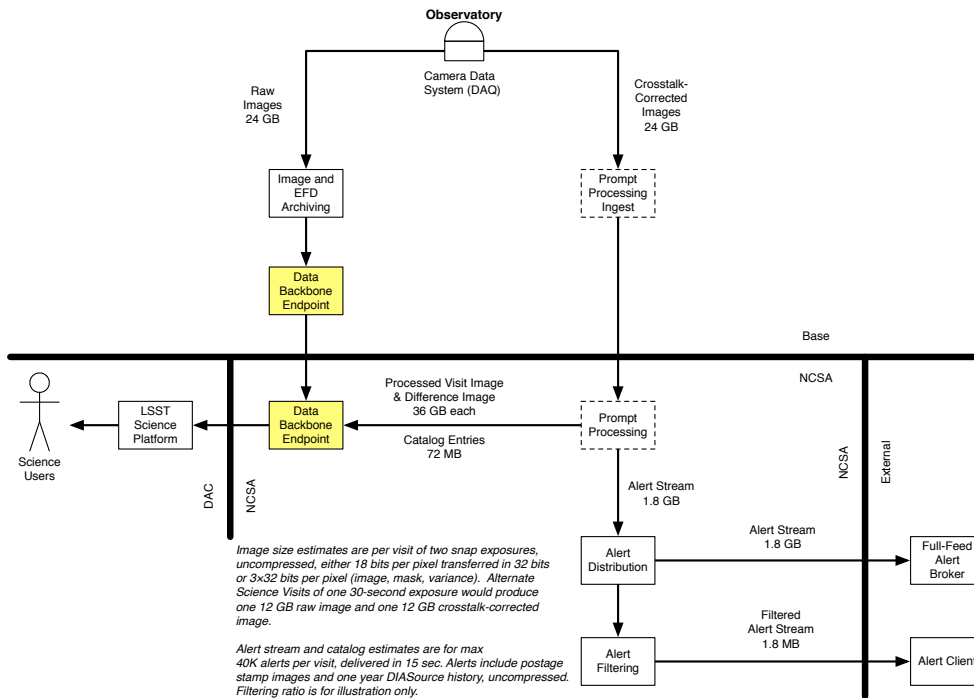


FIGURE 1: Near Real-Time Data Flows

In all of the above, conservative performance improvement factors were used to extrapolate to the LSST construction and operations phases in which the technology will be acquired, con-

figured, deployed, operated, and maintained. A just-in-time acquisition strategy is employed to leverage favorable cost/performance trends.

The resulting performance and sizing requirements show the DMS to be a supercomputing-class system with correspondingly large data input/output and network bandwidth rates. Despite this size, technology trends show this to be well within the anticipated performance of commodity-based systems during the construction and operations time frame.

## 4 Component Overview

The services that make up the DMS are in turn made up of software and underlying service components, instantiated in a particular configuration in a particular computing environment to perform a particular function. Some software components are specific to a service; others are general-purpose and reused across multiple services. Many services have only one instance in the production system; others have several, and all have additional instances in the development and integration environments for testing purposes.

The DMS services can be considered to consist of four tiers of software components. The top tier is the LSST Science Platform, which is deployed to provide a user interface and analysis environment for science users and LSST staff. The detailed design of this tier is given in *Science Platform Design* [LDM-542]. The next tier is composed of science “applications” software that generates data products. This software is used to build “payloads”, sequences of pipelines, that perform particular data analysis and product generation tasks. It is also used by science users and staff to analyze the data products. The detailed design of the components in this tier is given in *Data Management Science Pipelines Design* [LDM-151]. A lower tier is “middleware” software components and services that execute the science application payloads and isolate them from their environment, including changes to underlying technologies. These components also provide data access for science users and staff. The detailed design of the components in this tier is given in *Data Management Middleware Design* [LDM-152]. The bottom tier is “infrastructure”: hardware, networking, and low-level software and services that provide a computing environment. The detailed design of components in this tier is given in *LSST Data Facility Logical Information Technology and Communications Design* [LDM-129] and *LSST Observatory Network Design* [LSE-78].

The DMS computing environments reside in four main physical locations: the Summit Site

including the main Observatory and Auxiliary Telescope buildings on Cerro Pachon, Chile; the Base Facility data center located at the Base Site in La Serena, Chile; the US Data Facility data center at the National Center for Supercomputing Applications (NCSA) in Urbana, Illinois, USA; and a Satellite Facility at CC-IN2P3 in Lyon, France. These are linked by high-speed networks to allow rapid data movement. These computing environments are separated into enclaves by their requirements for availability, access, and change management.

The Base Facility includes four enclaves: the Base portion of the Prompt Enclave directly supporting Observatory operations, the Commissioning Cluster, an Archive Enclave holding data products, and the Chilean Data Access Center.

The US Data Facility also includes four enclaves: the US portion of the Prompt Enclave, the Offline Production Enclave hosting all offline “data release” and calibration activities, another Archive Enclave, and the US Data Access Center.

Additionally, a separate Development and Integration Enclave at NCSA hosts many of the services and tools necessary to build and test the DMS.

These enclaves are distinguished by having different users, operations timescales, interfaces, and often components. The service levels required of each enclave have relatively loose requirements set by the LSST System Requirements [LSE-29] and the Observatory System Specification [LSE-30], which are then flowed down to the Data Management System Requirements [LSE-61]. Some enclaves have goals for availability, processing latency, or other parameters that may be significantly more strict, however. The trade-offs between cost and availability and between availability and latency need to be evaluated carefully to ensure that the optimum balance is being struck. Requirement DMS-REQ-0161 already specifies that reliability (i.e. correctness and consistency of service) should be prioritized over availability to end users, given equal cost.

DMS services are assigned to each of these enclaves. Some enclave hardware may be dedicated; the remainder is allocated from Master Provisioning hardware pools at each Facility. Each service is generally implemented by a corresponding software product. In some cases, such as for the Archiving and Telemetry Gateway, multiple services are supported by a single software product. In other cases, such as for the Image Ingest and EFD Transformation portions of the Archiving service, multiple software products support a single overall service.

The service instances that make up the DMS include (with the enclave they are in noted):

- Archiving (Prompt Base)
- Planned Observation Publication (Prompt Base)
- Prompt Processing Ingest (Prompt Base)
- Observatory Operations Data (Prompt Base)
- Observatory Control System (OCS) Controlled Pipeline (Prompt Base)
- Telemetry Gateway (Prompt Base)
- Prompt Processing (Prompt US)
- Alert Distribution (Prompt US)
- Prompt Quality Control (QC) (Prompt US)
- Batch Production (Offline Production, Satellite Facility)
- Offline QC (Offline Production)
- Bulk Distribution (Offline Production)
- Data Backbone (Archive Base and US)
- LSST Science Platform Portal (Commissioning Cluster and DACs)
- LSST Science Platform Notebook (Commissioning Cluster and DACs)
- LSST Science Platform Web API (Commissioning Cluster and DACs)

The relationships between these services, their deployment enclaves physical facilities, and science application “payloads” can be visualized in Figure 2.

Other services necessary to build, test, and operate the DMS but that are not directly responsible for generating data products include:

- LSST Science Platform Science Validation instance (Development and Integration)
- Developer Services (Development and Integration)



FIGURE 2: Data Management System Deployment

- Managed Database (Infrastructure)
- Batch Computing (Infrastructure)
- Containerized Application Management (Infrastructure)
- IT Security (Infrastructure)
- Identity Management (Infrastructure)
- ITC Provisioning and Management (Infrastructure)
- Service Management/Monitoring (Infrastructure)

The common infrastructure services are illustrated in Figure 3.

The science application software for the Alert Production, daytime processing, Data Release Production, and calibration processing is built out of a set of libraries and frameworks that accept plugins. In turn, those frameworks build on middleware that provides portability and scalability. The relationships between the packages implementing these frameworks and plugins and the underlying middleware packages are shown in Figure 4.

The Science Pipelines Software product category contains the production pipelines that generate data products. Those rely on the Science Pipelines Libraries supporting software product, which includes these key components:

- Low-level astronomical software primitives and data structures (afw)
- Image processing and measurement framework with core algorithms (ip\_\*, meas\_\*)
- Additional image processing and measurement algorithms (meas\_extensions\_\*)
- High-level algorithms and driver scripts that define pipelines (pipe\_tasks, pipe\_drivers)
- Camera-specific customizations (obs\_\*)

Documentation for the Science Pipelines is available at [pipelines.lsst.io](https://pipelines.lsst.io).

The middleware layer includes software products that allow the building of algorithmic pipelines and abstract their data access.

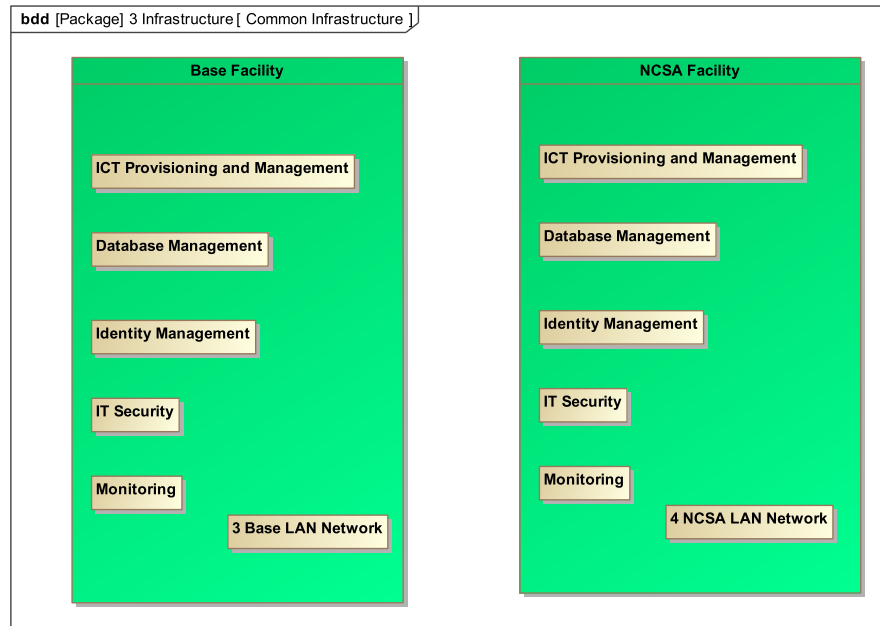


FIGURE 3: Data Management System Common Infrastructure Services

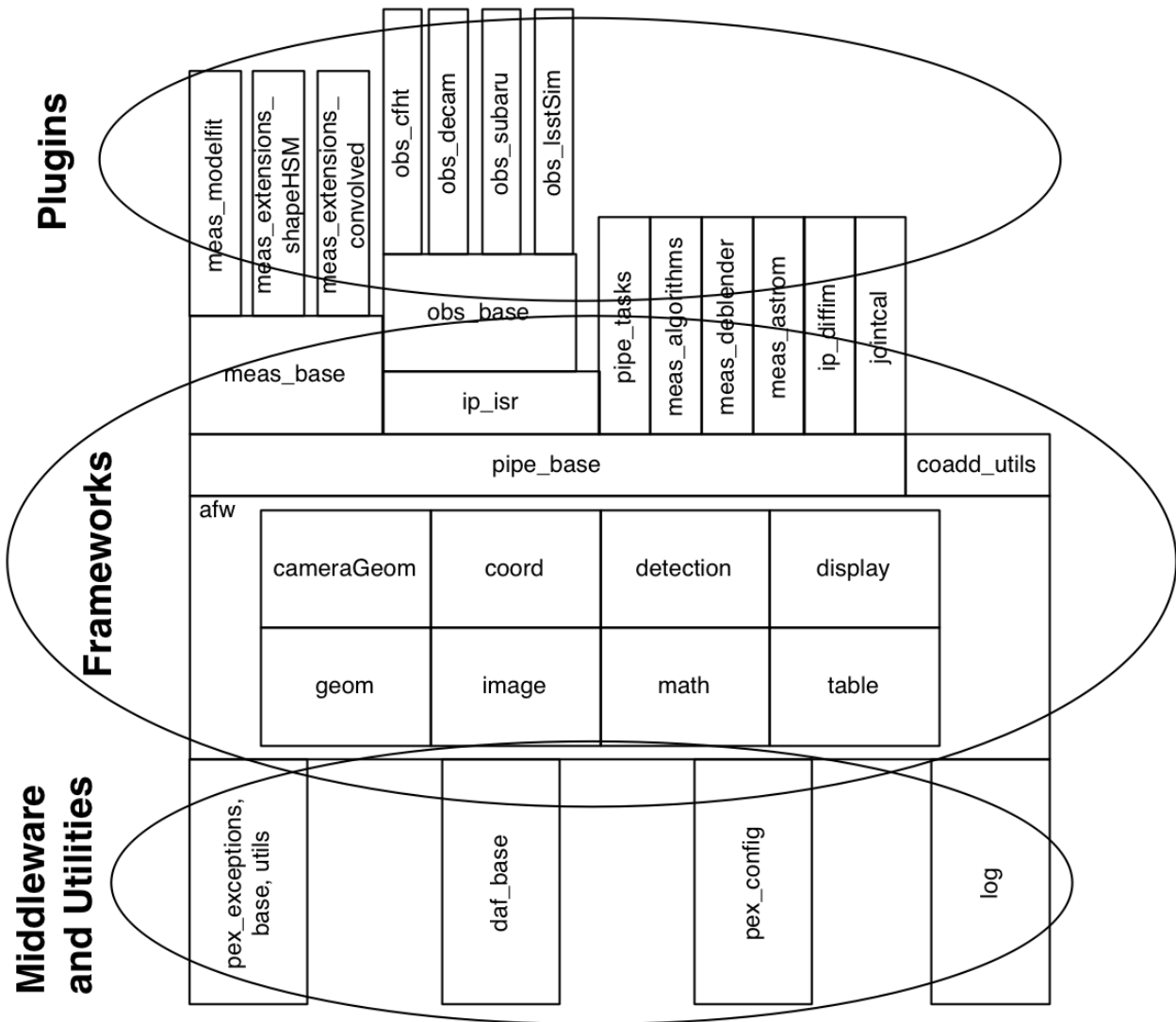


FIGURE 4: Data Management Science Pipelines Software "Stack"

- Data access client (Data Butler) (daf\_butler, daf\_persistence)
- Task framework (pex\_\*, log, pipe\_base, ctrl\_pool)

These pipelines are in turn executed and controlled by Batch Production software products:

- Campaign management (ctrl\_bps)
- Workload/workflow management

Infrastructure components include:

- Parallel distributed database (qserv)
- Other databases (typically relational)
- Common off-the-shelf software and other third-party products
- Low-level software such as operating systems
- Filesystems
- Authentication and authorization (identity management)
- Provisioning and resource management
- Monitoring
- Hardware (compute, storage, and network) configurations

The relationships between the middleware and infrastructure components are illustrated in Figure 5.

## 5 Prompt Base Enclave

Services located in this enclave are located at the Base solely because they must interact with the OCS or the Camera Data System (also known as the Camera DAQ) or both. In several cases,

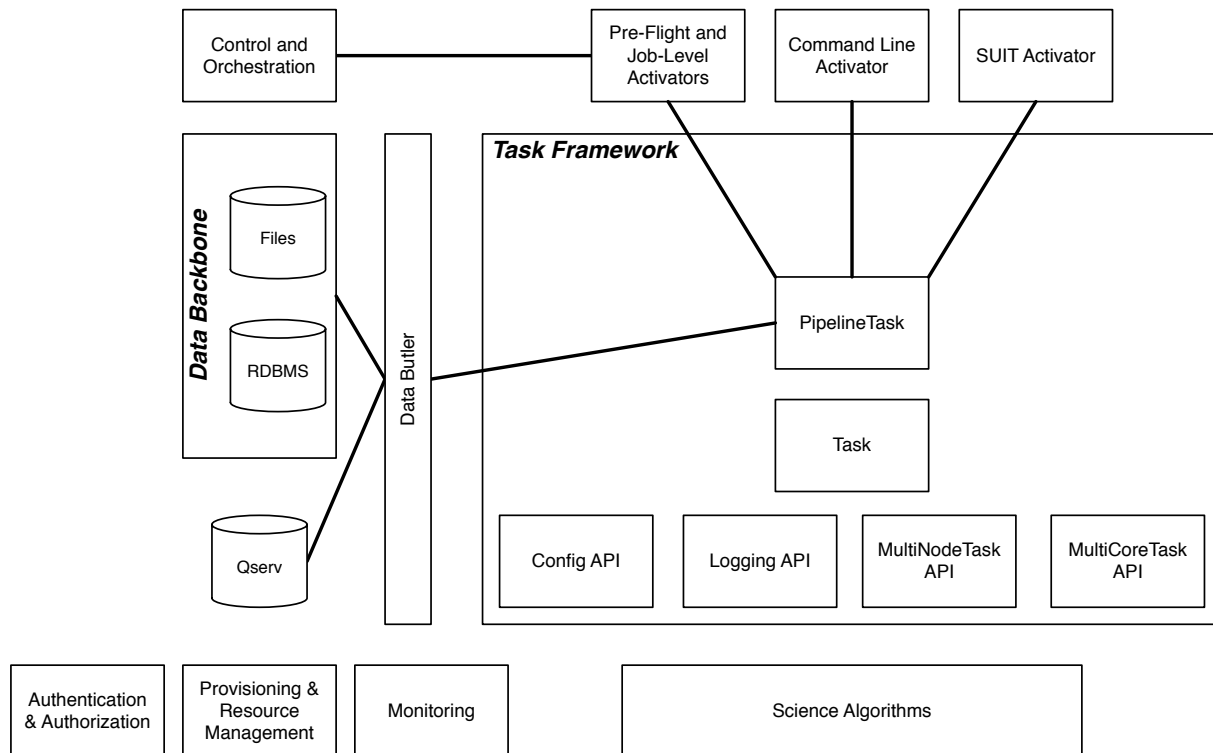


FIGURE 5: Data Management Middleware and Infrastructure

services located here interact closely with corresponding services in the Prompt US Enclave, to the point where the Base service cannot function if the US service is not operational. This reliance has been taken into account in the fault tolerance strategies used.

The primary goals of the services in this enclave are to transfer data to appropriate locations, either to the US, from the US, or to the Data Backbone.

The services in this enclave and their partners in the Prompt US Enclave need to run rapidly and reliably. They run at times (outside office hours) and with latencies that are not amenable to a human-in-the-loop design. Instead, they are designed to execute autonomously, often under the control of the OCS, with human oversight, monitoring, and control only at the highest level.

Historical designs for the equivalent of this enclave envisioned an overarching DM Control System (DMCS) that would be the sole externally-visible service controlling all others. The current design exposes each service as a separate entity with potentially different service levels.

The overall service level for this enclave should be high, with the goal being to have the enclave functional whenever the Observatory is taking data. Since these services are part of the normal functioning of the Observatory, they are also referred to as Observatory Operations Services.

Of the services within the enclave, the Header Generator component of the Archiving service is critical to observing and should have a target uptime equal to the Engineering and Facility Database.

The Archiving, Observatory Operations Data, OCS Controlled Pipeline, Prompt Processing Ingest, and Telemetry Gateway services are important for maintaining high-quality observing; lack of these services constitutes a degraded mode of operation without useful feedback loops. Downtime, defined as when observing is occurring but one or more of these services is unavailable, must be limited in both length and frequency. There are daily and annual observatory scheduled maintenance periods during which no observing occurs; accordingly, these services do not need to remain available during these periods. During normal observing, the stability of the telescope systems is expected to allow at most 24 consecutive hours of downtime during any single incident for the Archiving, Observatory Operations Data and OCS Controlled Pipeline services. (This might require reconfiguring OCS Controlled Pipeline to ex-

ecute on the Commissioning Cluster rather than in the Offline Production enclave.) Similarly, DMS-REQ-0008 requires that the pipelines fed by Prompt Processing Ingest and producing output via the Telemetry Gateway be down for no more than 24 hours at a time. These services must be available for at least 24 continuous hours out of any 48 hour period in order to maintain optimal Observatory scientific performance.

The overall Archiving service can prevent further observing if the capacity of the buffer in the Camera Data System (DAQ) at the Summit is exceeded, so it must be up sufficiently, particularly after a Summit-to-Base network outage, to drain that buffer.

All of these services need to function sufficiently to meet requirement DMS-REQ-0318, which says that DM as a whole must not prevent observing for more than 1 day total per year. As a result, the above limits on downtime can be exceeded, but only as long as total observing outages do not exceed 1 day when integrated over a year.

The Planned Observation Publication service provides information for external clients. Because it publishes advance predictions that are not guaranteed, it is acceptable for this service to be down during observing for an amount of time less than the prediction window. Having this service down does not prevent further observing.

## 5.1 Service Descriptions

Detailed concepts of operations for each service can be found in *Concept of Operations for the LSST Production Services* [LDM-230].

### 5.1.1 Archiving

This component is composed of several Image Archiver service and Catch-Up Image Archiver instances: one pair each for the LSSTCam, the ComCam, and the Auxiliary Telescope Spectrograph, all of which may be operated simultaneously. These capture raw images taken by each camera, including the wavefront sensors and the guide sensors of the LSSTCam or ComCam when so configured, retrieving them from their respective Camera Data System instances. The Image Archiver service for at least LSSTCam will be implemented using the Camera Control System's image writing component.

A Header Generator written by Data Management but operated by the Observatory captures specific sets of metadata associated with the images, including telemetry values and event timings, from the OCS publish/subscribe middleware and/or from the EFD. It formats these into a metadata package that is recorded in the EFD Large File Annex. The Archiver and Catch-Up Archiver instances retrieve this metadata package and attach it to the captured image pixels.

The image pixels and metadata are passed to the Observatory Operations Data Service (OODS), which serves as a buffer from which observing-critical data can be retrieved. They are also passed to a staging area for ingestion into the permanent archive in the Data Backbone. The catch-up versions archive into the OODS and Data Backbone any raw images and metadata that were missed by the primary archiving services due to network or other outage, retrieving them from the flash storage in the Camera Data System instances and the EFD.

This component also includes an EFD Transformation service that extracts all information (including telemetry, events, configurations, and commands) from the EFD and its large file annex, transforms it into a form more suitable for querying by image timestamp, and loads it into the permanently archived “Transformed EFD” database in the Data Backbone.

### 5.1.2 Planned Observation Publication

This service receives telemetry from the OCS describing the next visit location and the telescope scheduler’s predictions of its future observations. It publishes these as an unauthenticated, globally-accessible web service comprising both a web page for human inspection and a web API for usage by automated tools.

### 5.1.3 Prompt Processing Ingest

This component is composed of two instances that capture raw images from the LSSTCam and ComCam Camera Data Systems along with selected metadata from the OCS and/or EFD and transfer them to the Prompt Processing service in the Prompt US Enclave.

There is no Prompt Processing Ingest instance for the auxiliary telescope spectrograph.

### 5.1.4 Observatory Operations Data

This service (OODS) provides low-latency access to images, other files, and metadata for use by Observatory systems and the Commissioning Cluster LSP instance. It maintains a higher level of service availability than the Data Backbone. After images, files, and metadata are ingested, they remain available through the OODS for a policy-configured amount of time. Files stored in the OODS include raw images from the Camera as well as master calibration images from the Calibration Products Production payloads, intended for use by the Active Optics and Guider components of the Telescope and Site subsystem.

### 5.1.5 OCS Controlled Pipeline

This service (OCPS) receives commands from the OCS and invokes a Batch Computing service to execute configured science payloads. The service can be configured to execute on the Commissioning Cluster at the Base or in the Offline Production Enclave at the US Data Facility. It is used for modest-latency automated analysis of images during Commissioning and for processing daily calibration images in normal observing operations, under the control of an observing script. Images and metadata are taken from the OODS or Data Backbone, and results are provided back to the OODS if temporary or the Data Backbone if permanent; there is no direct connection from this service to the Camera Data System. A summary status for the processing performed is sent to the OCS Controlled Pipeline Service to be returned to the OCS.

### 5.1.6 Telemetry Gateway

This service obtains information from the Prompt US Enclave, particularly status and quality metrics from Prompt Processing of images and the Prompt Quality Control service, and transmits it to the OCS as specified in the *Data Management-OCS Software Communication Interface* [LSE-72]. Note that more detailed information on the status and performance of DMS services will also be available to Observatory operators through remote displays originated from the Service Management/Monitoring infrastructure services in all DMS enclaves.

## 5.2 Interfaces

OCS to all Prompt Base Enclave services: these interface through the SAL library provided by the OCS subsystem.

Archiver and Catch-Up Archiver to Observatory Operations Data Service: image files with associated metadata are written to OODS storage.

Archiver and Catch-Up Archiver to Data Backbone: files are copied to Data Backbone storage via a file transfer mechanism, and their information and metadata are registered with Data Backbone management databases. The Data Butler is not used for this low-level, non-science-payload interface.

Observatory Operations Data Service to Data Backbone: files are copied from the Data Backbone to the OODS after completion and validation of calibration production results.

Observatory Operations Data Service to Commissioning Cluster LSP and other users: the OODS provides a mountable POSIX filesystem interface. A web interface (e.g. WebDAV) may also be provided, but this will be as simple as possible to enable maintaining a very high level of service availability and reliability.

EFD to EFD Transformer: this interface is via connection to the databases that make up the EFD as well as file transfer from the EFD's Large File Annex.

EFD Transformer to Data Backbone: Transformed EFD entries are inserted into the "Transformed EFD" database resident within the Data Backbone.

Camera Data System to Archiver, Catch-Up Archiver, Prompt Processing Ingest: these interface via the Camera Image Writer component of the Camera Control System or through the custom library provided by the Camera Data System.

Prompt Processing Ingest to Prompt Processing: BBFTP is used to transfer files over the international network from the ingest service to the processing service.

OCS Controlled Pipeline to Batch Computing: HTCondor is used to transfer execution instructions from the control service to the batch service, whether to the Commissioning Cluster or

over the international network to the Offline Production Enclave, and return status and result information.

Telemetry Gateway from Prompt US Enclave services: RabbitMQ or Kafka (TBD) are used to transfer status and quality metrics to the gateway over the international network.

## 6 Prompt US Enclave

This enclave is responsible for the compute-intensive processing for all near-realtime operations and other operations closely tied with the Observatory. Its primary goals are to process images and metadata from the Observatory into “online” science data products and publish them to the DACs, alert subscribers, and back to the OCS.

The Prompt Processing service executes science payloads that are tightly integrated with the observing cadence and is intended to function in near-realtime with strict result deadlines for both science and raw calibration images.

Note that offline (typically daytime) processing to generate Prompt data products occurs under the control of the Batch Production service in the Offline Production Enclave using its Batch Computing resources.

The Alert Distribution service receives batches of alerts resulting from Prompt Processing of each science visit; it then provides bulk alert streams to community alert brokers and filtered alert streams to LSST data rights holders.

The Prompt Quality Control service monitors the “online” science data products, including alerts, notifying operators if any anomalies are found.

Like the services in the Base Center, these services need to run rapidly and reliably and so are designed to execute autonomously.

The services in this enclave are important parts of the observing feedback system and the prompt DM pipelines and accordingly should have a target of being up whenever the Observatory is taking data. They should be down (while observing is taking place) for no more than 24 hours at a time (DMS-REQ-0008), although additional downtime adding up to no more than

1 day per year (DMS-REQ-0318) can be tolerated. Latency for services in this enclave must be low in order to meet the 60 second alert delivery requirement.

## 6.1 Service Descriptions

Detailed concepts of operations for each service can be found in *Concept of Operations for the LSST Production Services* [LDM-230].

### 6.1.1 Prompt Processing

This service receives raw images and metadata from the Prompt Processing Ingest service at the Base and executes the Alert Production science payload on them, generating “online” data products that are stored in the Data Backbone. The Alert Production payload then sends alerts to the Alert Distribution service.

The Prompt Processing service has calibration (including Collimated Beam Projector images), science, and deep drilling modes. In calibration mode, it executes a Raw Calibration Validation payload that provides rapid feedback of raw calibration image quality. In normal science mode, two consecutive exposures are grouped and processed as a single visit. Definitions of exposure groupings to be processed as visits in deep drilling and other modes are TBD. The service is required to deliver Alerts within 60 seconds of the final camera readout of a standard science visit with 98% availability.

There is no Prompt Processing service instance for the Auxiliary Telescope Spectrograph.

### 6.1.2 Alert Distribution

This service obtains alerts generated by the Alert Production science payload and distributes them to community alert brokers. A full Alert stream is also fed to a filtering component (also known as the “mini-broker”); that component allows individual LSST data rights holders to execute limited filters against the stream, producing filtered feeds that are then distributed to the individuals.

### 6.1.3 Prompt Quality Control

This service collects information on Prompt science and calibration payload execution, post-processes the science data products from the Data Backbone to generate additional measurements, and monitors the measurement values against defined thresholds, providing an automated quality control capability for potentially detecting issues with the environment, telescope, camera, data acquisition, or data processing. Alarms stemming from threshold crossings are delivered to Observatory operators and to LSST Data Facility Production Scientists for verification, analysis, and resolution.

## 6.2 Interfaces

Prompt Processing to Alert Distribution: these interface through a reliable transport system.

Prompt Processing to Batch Production: in the event that Prompt Processing runs over its allotted time window, processing can be canceled and the failure recorded, after which Offline Processing within the Batch Production service will redo the processing at a later time. Note that it may be possible, if sufficient computational resources have been provisioned, for the Prompt Processing to be allowed to continue to run, with spare capacity used to maintain latency for future visits. In that case, there would effectively be an infinite time window.

Science Payloads to Data Backbone: payloads use the Data Butler as a client to access files and catalog databases within the Data Backbone.

## 7 Offline Production Enclave

This enclave is responsible for all longer-period data processing operations, including the largest and most complex payloads supported by the DMS: the annual Data Release Production (DRP) and periodic Calibration Products Productions (CPPs). Note that CPPs will execute even while the annual DRP is executing. The Offline Quality Control Service monitors the science data products, notifying operators if any anomalies are found. The enclave also includes a service for distributing bulk data on daily and annual (Data Release) timescales to partner institutions, collaborations, and LSST Education and Public Outreach (EPO). This bulk data transfer may occur in large batches (e.g. once per day or when a Data Release is about

to occur) or in narrower streams (e.g. as candidate data products become available from the Data Release Production).

The services in this enclave need to run efficiently and reliably over long periods of time, spanning weeks or months. They need to execute millions or billions of tasks when their input data becomes available while tracking the status of each and preserving its output. They are designed to execute autonomously with human oversight, monitoring, and control primarily at the highest level, although provisions are made for manual intervention if absolutely necessary.

This enclave does not have direct users (besides the operators of its services); the services within it obtain inputs from the Data Backbone and place their outputs (if any) into the Data Backbone.

Requirement DMS-REQ-0008 places a limit of 24 hours on each unscheduled outage of this enclave. Otherwise, downtime is limited by the need to generate timely calibration products and annual Data Release data products. This is expected to allow no more than 1 week of integrated scheduled or unscheduled downtime (e.g. half of the enclave down for two weeks) per year for this enclave. Because the total capacity of this enclave is needed in order to provide the throughput necessary to complete the productions in the allotted time, any outage that decreases capacity is relevant, even if it occurs as part of a rolling maintenance in which services remain running. There are no particular latency requirements for services in this enclave, other than what is necessary in order to meet the periodic Calibration Products and annual Data Release cycles.

## 7.1 Service Descriptions

### 7.1.1 Batch Production

This service executes science payloads as "campaigns" consisting of a defined pipeline, a defined configuration, and defined inputs and outputs. Many different payloads may be executed on many different campaign cadences. These include:

- Offline processing for Prompt data products
- Calibration Products Production

- Template Production
- Special Programs Productions
- Data Release Production

The service is able to handle massively distributed computing, executing jobs when their inputs become available and tracking their status and outputs. It ensures that the data needed for a job is accessible to it and that outputs (including log files, if any) are preserved. It can allocate work across multiple enclaves, in particular between the US Data Facility and the Satellite Facility, each of which will have capacity for half of the DRP processing. It utilizes the Campaign Management and Workload/Workflow Management software products to accomplish these goals.

Offline processing ensures that Prompt data products are generated within the nominal 24 hours. It includes catch-up of missed nightly processing as well as daytime processing such as the Solar System Processing System.

Calibration Products Production campaigns execute various CPP science payloads at intervals to generate Master Calibration Images and other Calibration Products containing information derived from analysis of raw calibration images from the Data Backbone and information in the Transformed EFD. This includes the computation of crosstalk correction matrices. Additional information such as external catalogs are also taken from the Data Backbone. The intervals at which this service executes will depend on the stability of Observatory systems but are expected to include at least monthly and annual executions. The annual execution is a prerequisite for the subsequent execution of the Data Release Production. The service involves human scientist/operator input to determine initial configurations of the payload, to monitor and analyze the results, and possibly to provide additional configuration information during execution.

Template Production campaigns, typically run annually, generate the static sky templates used by Alert Production, based on raw science images from the Data Backbone.

Special Programs Productions campaigns perform custom analyses on raw science images taken for these programs. The cadence for these campaigns may vary based on the particular Special Program.

Data Release Production campaigns execute the DRP science payload annually to generate all Data Release data products after the annual CPP is executed. A small-scale (about 10% of the sky) mini-production is executed first to ensure readiness, followed by the full production. Raw science images are taken from the Data Backbone along with Master Calibration Images and information from the Transformed EFD. Additional information such as external catalogs may also be taken from the Data Backbone.

Output data products from both the mini-production and the main production are loaded into the Data Backbone, including both images and catalogs. From there, they are analyzed by LSST staff scientists and selected external scientists using the Science Validation instance of the LSST Science Platform to ensure quality and readiness for release. The to-be-released data products are loaded into the Data Access Center services, and access is then enabled on the release date. The service involves human scientist/operator/programmer input to determine initial configurations of the payload, to monitor and analyze results, and, when absolutely necessary, to make “hot fixes” during execution that maintain adequate consistency of the resulting data products.

### 7.1.2 Offline Quality Control

This collects information on Calibration, Template Generation, and Data Release science payload execution, post-processes the science data products from the Data Backbone to generate additional measurements, and monitors the measurement values against defined thresholds, providing an automated quality control capability for potentially detecting issues with the data processing but also the environment, telescope, camera, or data acquisition. Alarms stemming from threshold crossings are delivered to LSST Data Facility Production Scientists for verification, analysis, and resolution.

### 7.1.3 Bulk Distribution

This service is used to transmit Prompt and Data Release data products to partners such as LSST Education and Public Outreach, the UK LSST project, and the Dark Energy Science Collaboration. It extracts data products from the Data Backbone and transmits them over high bandwidth connections to designated, pre-subscribed partners.

## 7.2 Interfaces

**Batch Production to Data Backbone:** for large-scale productions, a workflow system is expected to stage files and selected database entries from the Data Backbone to local storage for access by the science payloads via the Data Butler. Similarly, the staging system will ingest output images and catalogs into the Data Backbone.

**Batch Production to Satellite Facility:** the Data Backbone will transfer raw data, including images, metadata, and the Transformed EFD, to the Satellite Facility. Intermediate data products will be transferred back via the Data Backbone for further computations in the Offline Production Enclave.

**Bulk Distribution to Data Backbone:** all data products sent via Bulk Distribution are retrieved from the Data Backbone.

**Bulk Distribution to partners:** the exact delivery mechanism for large-scale data distribution is TBD.

## 8 Data Access Centers

There are two Data Access Centers, one in the US at the US Data Facility and one in Chile at the Base. These DACs are responsible for all science-user-facing services, primarily instances of the LSST Science Platform (LSP). The LSP is the preferred analytic interface to LSST data products in the DAC. It provides computation and data access on both interactive and asynchronous timescales.

The services in each enclave must support multiple users simultaneously and securely. The LSP must be responsive to science user needs; updates are likely to occur at a different cadence from the other enclaves as a result. The LSP must operate reliably enough that scientific work is not impeded.

OSS-REQ-0180 states that data products should be available from the DACs 98% of the time, including scheduled and unscheduled downtime, and that a single outage can last at most 3 working days. The Bulk Distribution service is expected to be used heavily around the time of a Data Release (possibly both before and after); it should have minimal downtime during

those periods but can have lower availability otherwise.

## 8.1 Service Descriptions

### 8.1.1 LSST Science Platform DAC instances

This service provides an exploratory analysis environment for science users. It can be further broken down into three “Aspects” that it presents to end users, along with underlying “backend services” that users can take advantage of, as illustrated in Figure 6.

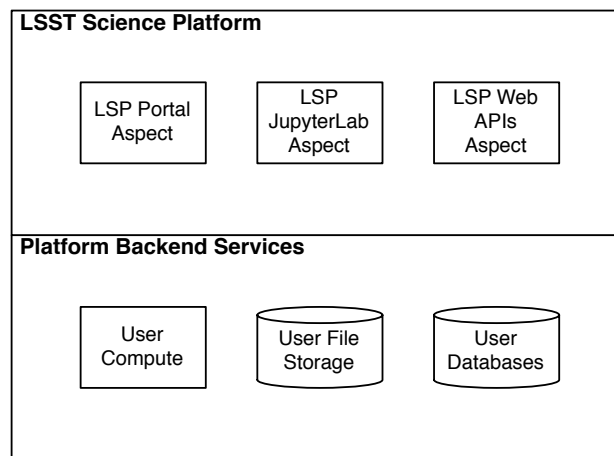


FIGURE 6: LSST Science Platform

The “Portal” Aspect provides a pre-specified yet flexible discovery, query, and viewing tool. The “Notebook” Aspect provides a fully flexible environment incorporating rendering of images, catalogs, and plots and providing for execution of LSST-provided and custom algorithms. The “Web API” Aspect provides a language-independent, VO-compliant Web Services data access API with extensions for LSST capabilities and volumes. Access is provided via all three Aspects to all data products, including images, catalogs, and metadata. The Web API Aspect regenerates “virtual” data products on demand when required.

The backend services provide general-purpose user computation, including batch job submission from the Containerized Application Management Service and Batch Computing Service pools; file storage for User Generated data products which is accessible to all three Aspects and in particular exposed through one or more Web API Aspect services; and database storage for User Generated relational tables which is also accessible to all three Aspects. User Generated data may be shared with individual users, with groups, or with all DAC users (data

rights holders). Resource management of the backend services is based on a small “birthright” quota with additional resources allocated by a committee.

LSST Science Platform instances access read-only data products, including files and databases, from the Data Backbone. In addition, files may be cached within the LSP instance for speed, and large-scale catalogs are typically loaded into an instance of the Qserv database management system for efficient query and analysis.

All usage of any LSST Science Platform instance requires authentication to ensure availability only to LSST data rights holders or LSST operations staff.

## 8.2 Interfaces

LSST Science Platform to Data Backbone: the LSP services retrieve their data, including raw images, nightly and annual image and catalog data products, metadata, and provenance, from the Data Backbone. The LSP Portal Aspect uses the LSP Web APIs to retrieve data. The LSP Notebook Aspect can use the LSP Web APIs and also can use the Data Butler client library to access the Data Backbone.

## 9 Commissioning Cluster

The Commissioning Cluster enclave provides important services to the Observatory for rapid-turnaround human-driven ad hoc analysis of data during the Commissioning period and any re-commissioning of the system (e.g. after extended maintenance). These analyses will be used for debugging the Observatory system; inability to perform such analyses can delay verification and validation in Commissioning. In addition, this enclave supports human-driven quality control at the Base. As a result, the goal should be to have this cluster functioning whenever the Observatory is taking data as well as during the day, except for scheduled day-time outages coordinated with Commissioning activities. While it is operating, the latency of data delivery to the enclave by the OODS needs to be as low as feasible to support tight feedback loops during Commissioning. It is desirable but not required to have low Data Backbone latency for delivery of pipeline outputs. This enclave is separate as its human-centered services are distinct from the automated ones in the Prompt Base enclave.

## 9.1 Service Description

### 9.1.1 LSST Science Platform Commissioning instance

This instance of the LSST Science Platform for Science Validation runs on the Commissioning Cluster at the Base Facility (but also has access to computational resources at the Archive) and accesses a Base endpoint for the Data Backbone. This location at the Base lowers the latency of both access to Data Backbone-resident data (which does not have to wait for transfer over the international network) and, perhaps more importantly, for user interface operations for staff in Chile, which are served locally. Note that the Commissioning Cluster does not have direct access to the Camera Data System; it relies on the Archiver service to obtain data. The Commissioning Cluster will have direct access to the OCS's Base replica of the EFD (before transformation).

## 9.2 Interfaces

Commissioning Cluster to Data Backbone: The Commissioning Cluster relies on the Data Backbone for its historical data, like the other instances of the LSST Science Platform.

Commissioning Cluster to OODS: The Commissioning Cluster obtains its freshest, most recent data from the OODS.

Commissioning Cluster to EFD: The Commissioning Cluster has direct read-only client access to the Base replica of the EFD (before transformation).

## 10 Backbone Services

Detailed concepts of operations for each service can be found in *Concept of Operations for the LSST Production Services* [LDM-230].

The Backbone enclaves supply data to other services. As a result, the availability and latency requirements of the enclaves are constrained by those of the services it feeds. In general, the system has been designed so that the Data Backbone is not essential for normal Observatory data-taking. Latency requirements are thus loose, with permissible worst-case delivery times

of up to 24 hours, although shorter normal-case latencies on the order of seconds are desirable for staff and science users alike. Availability is primarily set by the need to support the Data Access Centers' 98% availability and maximum three-working-day downtime.

## 10.1 Service Descriptions

The Data Backbone (DBB) is a key component that provides for data storage, transport, and replication, allowing data products to move between enclaves. This service provides policy-based replication of files (including images and flat files to be loaded into databases as well as other raw and intermediate files) and databases (including metadata about files as well as other miscellaneous databases but not including the large Data Release catalogs) across multiple physical locations, including the Base, Commissioning Cluster, US Data Facility, and DACs. It manages caches of files at each endpoint as well as persistence to long-term archival storage (e.g. tape). It provides a registration mechanism for new datasets and database entries and a retrieval mechanism compatible with the Data Butler.

The relationships between the Data Backbone components are illustrated in Figure 7.

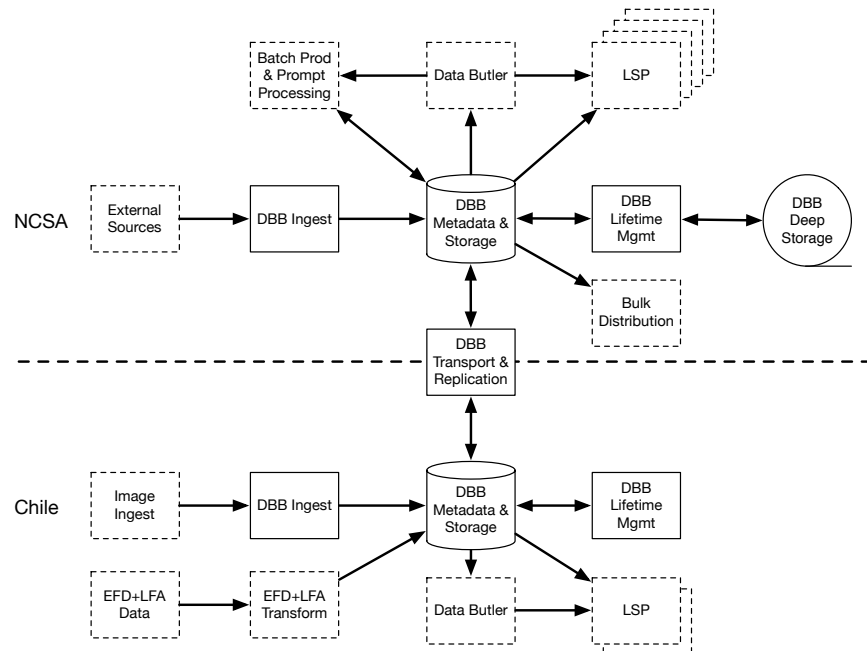


FIGURE 7: Data Backbone

### 10.1.1 DBB Ingest/Metadata Management

This service within the Data Backbone is responsible for maintaining and providing access to the metadata describing the location, characteristics, and provenance of the data products it manages. Part of this service involves creating the appropriate metadata during ingest when data from external sources is incorporated into the DBB. The Batch Production services will generally create the necessary DBB metadata as part of their operation, so only a minimal ingest process is needed for internally-generated data products. Metadata is kept in a database that is a superset of the registry required by the Data Butler, allowing the Butler to directly access data within the DBB.

### 10.1.2 DBB Lifetime Management

This service is responsible for managing the lifetimes of data products within the DBB based on a set of policies. Products may move from high-speed storage to near-line or offline storage or may be deleted completely. Some products are kept permanently. Some are kept for defined time periods as specified in requirements. Intermediates may be kept until all downstream products have been generated.

### 10.1.3 DBB Transport/Replication/Backup

This service is responsible for moving data products from one Facility to another and to backup and disaster recovery storage. It handles recovery if a data product is found to be missing or corrupt.

### 10.1.4 DBB Storage

This service is responsible for storage of data products in the DBB. The storage service provides an interface usable by the Data Butler as a datastore.

## 10.2 Interfaces

The Data Backbone services interact with most other deployed services.

## 11 Software Components

DM is responsible for delivering a set of operational services, as described above, and most of those are implemented by custom or customized software components. The implementing software products are distinct from the service products as they do not include configurations needed for deploying the service in different environments. This section describes some of the software products that are not directly tied to corresponding services.

### 11.1 Science Payloads

These payloads are described in more detail in the DM Applications Design Document [LDM-151]. Payloads are built from application software components from the Science Pipelines Libraries or third-party products. They specify inputs, outputs, and algorithmic configurations as well as the order of execution of science algorithms from those libraries. Most payloads execute under control of the Batch Production service. Exceptions include the Alert Production Payload and some of the Calibration Software.

#### 11.1.1 Alert Production Payload

Described in sections 3.1 to 3.3 of [LDM-151]. Executes under control of the Prompt Processing service. Generates all Prompt science data products including Alerts (with the exception of Solar System object orbits) and loads them into the Data Backbone and Prompt Products Database. Transmits Alerts to Alert Distribution service. Generates image quality feedback to the OCS and observers via the Telemetry Gateway. Uses raw science images and associated metadata delivered by the Prompt Processing service; uses Master Calibration Images, Template Images, Prompt Products Database, and Calibration Products information from the Data Backbone.

#### 11.1.2 Calibration Software

Described in Section 4 of [LDM-151]. Executes under control of the Prompt Processing service, OCS-controlled batch processing, and offline batch production at intervals ranging from per-exposure to daily to annual, depending on the stability of Observatory systems and their calibrations. Generates all Calibration Products. Provides raw calibration image quality feedback to the OCS and observers via the Telemetry Gateway. Uses raw science images and as-

sociated metadata delivered by the Prompt Processing service in addition to raw calibration images, Auxiliary Telescope images, and Master Calibration Images from the Data Backbone and EFD information from EFD Transformation and the Data Backbone.

### 11.1.3 Data Release Production Payload

Described in Section 5 of [LDM-151]. Executes at annual intervals, first running a “mini-DRP” over a small portion of the sky, followed by the full DRP over the entire sky. Produces science data products in the Data Backbone.

### 11.1.4 Solar System and Forced Photometry Payload

Described in Sections 3.4 and 3.5 of [LDM-151]. Executes after a night’s observations are complete. Generates entries in the Solar System Database and the Prompt Products Database, including Solar System Object records, measurements, and orbits. Performs precovery forced photometry of transients. Uses Prompt Products Database entries and images from the Data Backbone.

### 11.1.5 Special Programs Productions Payload

Composed of components from Sections 6 and 7 of [LDM-151]. Executes at program-defined intervals. Uses raw science images to generate special programs science data products, placing them in the Data Backbone.

### 11.1.6 Template Generation Payload

Described in Section 5.2.4 of [LDM-151]. Executes if necessary to generate templates for Alert Production in between annual Data Release Productions. Uses raw science images to generate the templates, placing them in the Data Backbone.

## 11.2 SUIT

The Science User Interface and Tools, primarily composed of the Firefly product, provide visualization, plotting, catalog rendering, browsing, and searching elements that can be assem-

bled into predetermined “portals” but can also be used flexibly within dynamic “notebook” environments.

## 11.3 Supporting Software

These software products, plus the middleware in the next subsection, are key underlying components to services and other software products.

### 11.3.1 Science Pipelines Libraries

These libraries provide objects, data structures, algorithms, and frameworks for writing Science Payloads. These libraries contain the key scientific analysis routines used to perform processing and measurement to generate the LSST data products.

### 11.3.2 Distributed Database (Qserv)

The petabyte-scale, tens-of-trillions-of-rows catalogs produced by LSST are served to users by the catalog query portion of the LSST Science Platform Web APIs aspect in the Data Access Centers. A custom parallel distributed database provides the required performance for these large and heavily-used catalogs that are resident in the DACs.

### 11.3.3 ADQL Translator

The ADQL (Astronomical Data Query Language) Translator serves to connect the catalog query portion of the LSST Science Platform Web APIs aspect, including its VO-standard TAP interface, with underlying databases, including both the Parallel Distributed Database (Qserv) and conventional relational databases.

### 11.3.4 Image/Cutout Server

The Image Server connects the image query portion of the LSST Science Platform Web APIs aspect with underlying image data products in the Data Backbone. It also serves to regenerate “virtual” data products that have been removed for space reasons.

## 11.4 Middleware

The detailed design of the Middleware components is in *Data Management Middleware Design* [LDM-152].

### 11.4.1 Data Butler Access Client

The Data Butler provides an access abstraction for all science payloads that enables their underlying data sources and destinations to be configured at runtime with a variety of back-ends ranging from local disk to network locations and a variety of serializations ranging from YAML and FITS files (extensible to HDF5 or ASDF) to database tables. The Butler client is also available within the LSST Science Platform Notebook environment.

### 11.4.2 Task Framework

The Task Framework is a Python class library that provides a structure (standardized class entry points and conventions) to organize low-level algorithms into potentially-reusable algorithmic components (Tasks; e.g. dark frame subtraction, object detection, object measurement), and to organize tasks into basic pipelines (SuperTasks; e.g., process a single visit, build a coadd, difference a visit). The algorithmic code is written into (Super)Tasks by overriding classes and providing implementation for standard entry points. The Task Framework allows the pipelines to be constructed and run at the level of a single node or a group of tightly-synchronized nodes. It allows for sub-node parallelization: trivial parallelization of Task execution, as well as providing (in the future) parallelization primitives for development of multi-core Tasks and synchronized multi-node Tasks.

The Task Framework serves as an interface layer between orchestration and the algorithmic code. It exposes a standard interface to “activators” (command-line runners as well as the orchestration layer and QA systems), which use it to execute the code wrapped in tasks. The Task Framework does not concern itself with fault-tolerant massively parallel execution of the pipelines over multiple (thousands) of nodes nor any staging of data that might be required; this is the concern of the orchestration middleware.

The Task Framework exposes to the orchestration system needs and capabilities of the underlying algorithmic code (i.e., the number of cores needed, expected memory-per-core, ex-

pected need for data). It may also receive from the orchestration layer the information on how to optimally run the particular task (i.e., which level of intra-node parallelization is desired).

It also includes a configuration API and a logging API.

## 12 Infrastructure Services

The information technology and communications infrastructure is composed of services and systems that form the computing environments on top of which the services in the enclaves described above are deployed and operate.

### 12.1 Service Descriptions

Detailed concepts of operations for each service can be found in *Concept of Operations for the LSST Production Services* [LDM-230]. The detailed design of the infrastructure is in *LSST Data Facility Logical Information Technology and Communications Design* [LDM-129] and *Network Design* [LSE-78].

#### 12.1.1 Managed Database

This service provides general-purpose relational database management that supports other services. It includes metadata and provenance, but it does not include the large catalog science data products that are generated as files and loaded into the Qserv parallel distributed database. For efficiency of resource usage and management, most databases are consolidated into a single RDBMS instance.

#### 12.1.2 Batch Processing

This service provides execution of batch jobs with a variety of priorities from a variety of users in a variety of environments (e.g. OS and software configurations) on the underlying provisioned compute resources. It will use containerization to handle heterogeneity of environments. HTCondor is the baseline technology choice for this service.

Some compute resources are reserved for particular uses, but others can be flexibly provisioned, up to a certain maximum quota, if needed to deal with surges in processing.

The priority order for processing is:

- Prompt processing
- Offline processing for Prompt data products
- OCS-controlled batch processing
- LSP Commissioning Cluster processing
- LSP Science Validation processing
- LSP Data Access Center processing
- Template and Calibration Products Production
- Special Programs Productions
- Data Release Production

### 12.1.3 Containerized Application Management

This service provides compute, local-to-node storage, and local-to-LAN storage resources for deploying containerized service-oriented systems, especially the Science Platforms but also including parts of the Quality Control systems and Developer Services. It allows allocation of compute and storage resources as well as reproducible, controlled deployment of services onto those resources. Kubernetes is the baseline technology choice for this service.

### 12.1.4 IT Security

This service provides security, including monitoring, vulnerability management, incident detection and response, access controls, intrusion detection, and configuration management. Information security is provided in accordance with the *LSST Master Information Security Policy* [LPM-121].

### 12.1.5 Identity Management

This service provides authentication and authorization for all users of any DMS component, especially the LSST Science Platform instances.

### 12.1.6 ITC Provisioning and Management

This service provides for acquisition, change and configuration management, and provisioning of information technology components, whether purchased “bare metal”, shared with other projects at the US Data Facility, or provided by agreements with outside providers.

This service includes deployment of non-containerized services. For example, many of the services at the Base Facility are not highly dynamic or flexible, as they primarily provide interfacing to the OCS and Camera Data System. The baseline provisioning mechanism for them is vSphere; they will be deployed using Puppet.

### 12.1.7 Service Management/Monitoring

These services provide management and monitoring at the service level for each computing environment. They include standard IT processes such as service design, service transition (including change, release, and configuration management), and service delivery (including incident and request response plus problem management).

Service monitoring reports in dashboard and document form on the health and status of all services.

## 12.2 Interfaces

The infrastructure services generally interact with all other deployed services.

Identity management instances are present in the Base Center and at the US Data Facility. (Another replica will be maintained at the Summit.) These are used to support authentication and authorization for the other physically co-located environments: the Commissioning Cluster and the two Data Access Centers.

## 13 NCSA Development and Integration Enclave

This enclave encompasses environments for analysts, developers, and integration and test. Its users are the Observatory staff as they analyze raw data and processed data products to characterize them, develop new algorithms and systems, and test new versions of components and services before deployment.

Integration environments in this enclave represent various deployment environments, deployment services, test datasets, test execution services, metric measurement and tracking services. This environment includes the “Level 1” Test Stand, which includes a DM instance of the Camera DAQ used in an integration environment simulating the Base Center. It also includes the Prototype Data Access Center (PDAC), which is an integration environment simulating a Data Access Center.

### 13.1 Service Descriptions

#### 13.1.1 LSST Science Platform Science Validation instance

This instance of the LSST Science Platform is customized to allow access to unreleased and intermediate data products from the Alert, Calibration Products, and Data Release Productions. It is optimized for usage by scientists within the LSST Operations team, although selected external scientists can be granted access to assist with Science Validation. Part of the optimization is to size and configure the three Aspects of the LSP appropriately; in particular, more notebook usage and less portal usage is expected.

#### 13.1.2 Developer Services

These services include a software version control service, a build, unit test, and continuous integration service, a documentation publication service, developer communications services, an issue/ticket tracking service, etc., necessary to support science and system developers as they create and debug new versions of the Data Management System.

## 13.2 Interfaces

LSP Science Validation instance and Developer Services to Data Backbone: All services in this enclave interface with the Data Backbone. The LSP Science Validation instance is used to inspect, analyze, and validate the data products of the Data Release Production prior to their release and so has access to those products in the Data Backbone; since it may be used to annotate the data products, it can also write to the Data Backbone. The Developer Services may use raw data, intermediate data products, and final data products to do development, perform tests, and debug problems.

Developer Services do not have direct interfaces with the rest of the operational system; they communicate via the distributed source version control system, the package management system, and the configuration system.

## 14 Design and Implementation Standards

Standards have been adopted by the DM Change Control Board (CCB) that apply to all component designs within the LSST DM System. Coding standards and the like that are not pertinent to design may be found in the LSST DM Developer Guide ([12]).

### 14.1 HTTPS Protocol

In the absence of a specific technical justification and acceptance by the LSST Information Security Officer and DM Change Control Board, all Web-enabled user interfaces and Web services exposed to users and the public Internet will use the HTTPS protocol and not the HTTP protocol. To reiterate: this is only a default, and exceptions can be made when justified.

The covered interfaces include those of the three LSP Aspects (Portal, JupyterLab, and Web APIs).

The requirement to implement data access policies limiting data access to identified rights holders will require all, or nearly all, data access to be authenticated, providing a strong technical justification. In addition, it appears to be appropriate "technical best practice" in the current Internet environment, in the absence of good reasons to do otherwise.

## 15 Appendix: Traceability

### 15.1 Requirement to Component Traceability

| Requirement                                                                            | Components                                                                                                                                                                                     |
|----------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CA-DM-CON-ICD-0007 Provide Data Management Conditions data                             | Prompt Processing Ingest, Prompt Processing, Telemetry Gateway, Prompt Base Enclave                                                                                                            |
| CA-DM-CON-ICD-0008 Data Management Conditions data latency                             | Prompt Processing Ingest, Prompt Processing, Telemetry Gateway, Prompt Base Enclave                                                                                                            |
| CA-DM-CON-ICD-0013 Transport Camera image data                                         |                                                                                                                                                                                                |
| CA-DM-CON-ICD-0014 Provide science sensor data                                         | Archiving, Prompt Processing Ingest, Image Ingest and Processing, Prompt Base Enclave                                                                                                          |
| CA-DM-CON-ICD-0015 Provide wavefront sensor data                                       | Archiving, Prompt Processing Ingest, Image Ingest and Processing, Prompt Base Enclave                                                                                                          |
| CA-DM-CON-ICD-0016 Provide guide sensor data                                           | Archiving, Prompt Processing Ingest, Image Ingest and Processing, Prompt Base Enclave                                                                                                          |
| CA-DM-CON-ICD-0017 Data Management load on image data interfaces                       | Archiving, Prompt Processing Ingest, Image Ingest and Processing, Prompt Base Enclave                                                                                                          |
| CA-DM-CON-ICD-0019 Camera engineering image data archiving                             | Archiving, Image Ingest and Processing, Archive Base Enclave, Archive NCSA Enclave, Prompt Base Enclave, Prompt NCSA Enclave                                                                   |
| CA-DM-DAQ-ICD-0051 Crosstalk Correction                                                |                                                                                                                                                                                                |
| CA-DM-DAQ-ICD-0052 Correction constants for science sensors sourced by Data Management | Observatory Operations Data, Observatory Operations Data Service SW, Science Pipelines Distribution                                                                                            |
| DM-TS-CON-ICD-0002 Timing                                                              | Prompt Processing Ingest, Prompt Processing, Telemetry Gateway, Image Ingest and Processing, Prompt Base Enclave                                                                               |
| DM-TS-CON-ICD-0003 Wavefront image archive access                                      | Observatory Operations Data, Observatory Operations Data Service SW, Base Facility, NCSA Facility, Archive Base Enclave, Archive NCSA Enclave, Offline Production Enclave, Prompt Base Enclave |
| DM-TS-CON-ICD-0004 Use OCS for data transport                                          | Telemetry Gateway, Prompt Base Enclave                                                                                                                                                         |
| DM-TS-CON-ICD-0006 Data                                                                | Prompt Processing, Telemetry Gateway, Prompt Base Enclave                                                                                                                                      |
| DM-TS-CON-ICD-0007 Timing                                                              | Prompt Processing Ingest, Prompt Processing, Telemetry Gateway, Image Ingest and Processing, Prompt Base Enclave                                                                               |
| DM-TS-CON-ICD-0008 LSST Stack Availability                                             | Science Pipelines Libraries                                                                                                                                                                    |
| DM-TS-CON-ICD-0009 Calibration Data Products                                           | Observatory Operations Data, Prompt Base Enclave                                                                                                                                               |
| DM-TS-CON-ICD-0011 Data Format                                                         | Prompt Processing, Telemetry Gateway, Prompt Base Enclave                                                                                                                                      |
| DMS-REQ-0002 Transient Alert Distribution                                              | Prompt Processing, Alert Distribution, Alert Distribution SW, Alert Production, Prompt NCSA Enclave                                                                                            |

| Requirement                                                     | Components                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|-----------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| DMS-REQ-0004 Nightly Data Accessible Within 24 hrs              | Prompt Processing Ingest, Prompt Processing, Alert Distribution, Alert Distribution SW, EFD Transformation, Image Ingest and Processing, Alert Production, MOPS and Forced Photometry, Archive Base Enclave, Archive NCSA Enclave, DAC Chile Enclave, DAC US Enclave, Offline Production Enclave, Prompt Base Enclave, Prompt NCSA Enclave                                                                                                                                                                                                                |
| DMS-REQ-0008 Pipeline Availability                              | Archiving, Prompt Processing Ingest, Prompt Processing, OCS-Driven Batch, Telemetry Gateway, Alert Distribution, Batch Production, DBB Ingest/Metadata Management, DBB Transport/Replication/Backup, DBB Storage, Alert Distribution SW, EFD Transformation, Image Ingest and Processing, OCS Batch SW, Campaign Management, Workload/Workflow Management, DBB Ingest/Metadata Management SW, DBB Transport/Replication/Backup SW, Network Management, Base Facility, NCSA Facility, Offline Production Enclave, Prompt Base Enclave, Prompt NCSA Enclave |
| DMS-REQ-0009 Simulated Data                                     | Alert Production, Data Release Production                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| DMS-REQ-0010 Difference Exposures                               | Alert Production, Archive Base Enclave, Archive NCSA Enclave, Prompt NCSA Enclave                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| DMS-REQ-0018 Raw Science Image Data Acquisition                 | Archiving, Image Ingest and Processing, Prompt Base Enclave                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| DMS-REQ-0020 Wavefront Sensor Data Acquisition                  | Archiving, Image Ingest and Processing, Prompt Base Enclave                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| DMS-REQ-0022 Crosstalk Corrected Science Image Data Acquisition | Prompt Processing Ingest, Image Ingest and Processing, Prompt Base Enclave                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| DMS-REQ-0024 Raw Image Assembly                                 | Archiving, Image Ingest and Processing, Prompt Base Enclave                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| DMS-REQ-0029 Generate Photometric Zero-point for Visit Image    | Alert Production, Archive Base Enclave, Archive NCSA Enclave, Prompt NCSA Enclave                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| DMS-REQ-0030 Generate WCS for Visit Images                      | Alert Production, Archive Base Enclave, Archive NCSA Enclave, Prompt NCSA Enclave                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| DMS-REQ-0032 Image Differencing                                 | Alert Production, Data Release Production, Science Pipelines Libraries                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| DMS-REQ-0033 Provide Source Detection Software                  | Alert Production, Data Release Production, Science Pipelines Libraries                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| DMS-REQ-0034 Associate Sources to Objects                       | Data Release Production, Offline Production Enclave                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| DMS-REQ-0042 Provide Astrometric Model                          | Alert Production, Data Release Production, Science Pipelines Libraries                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| DMS-REQ-0043 Provide Calibrated Photometry                      | Alert Production, Data Release Production, Science Pipelines Libraries                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| DMS-REQ-0046 Provide Photometric Redshifts of Galaxies          | Data Release Production, Distributed Database, Offline Production Enclave                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| DMS-REQ-0047 Provide PSF for Coadded Images                     | Data Release Production, Offline Production Enclave                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

| Requirement                                                       | Components                                                                                                                                                                                                                                                                                    |
|-------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| DMS-REQ-0052 Enable a Range of Shape Measurement Approaches       | Alert Production, Data Release Production, Science Pipelines Libraries                                                                                                                                                                                                                        |
| DMS-REQ-0059 Bad Pixel Map                                        | Science Plugins, Science Pipelines Distribution, Offline Production Enclave                                                                                                                                                                                                                   |
| DMS-REQ-0060 Bias Residual Image                                  | Science Plugins, Science Pipelines Distribution, Offline Production Enclave                                                                                                                                                                                                                   |
| DMS-REQ-0061 Crosstalk Correction Matrix                          | Science Plugins, Science Pipelines Distribution, Offline Production Enclave                                                                                                                                                                                                                   |
| DMS-REQ-0062 Illumination Correction Frame                        | Science Plugins, Science Pipelines Distribution, Offline Production Enclave                                                                                                                                                                                                                   |
| DMS-REQ-0063 Monochromatic Flatfield Data Cube                    | Science Plugins, Science Pipelines Distribution, Offline Production Enclave                                                                                                                                                                                                                   |
| DMS-REQ-0065 Provide Image Access Services                        | LSP Web API, LSP Web API SW, Image/Cutout Server                                                                                                                                                                                                                                              |
| DMS-REQ-0068 Raw Science Image Metadata                           | Archiving, DBB Ingest/Metadata Management, Image Ingest and Processing, DBB Ingest/Metadata Management SW, Prompt Base Enclave                                                                                                                                                                |
| DMS-REQ-0069 Processed Visit Images                               | Alert Production, Archive Base Enclave, Archive NCSA Enclave, Prompt NCSA Enclave                                                                                                                                                                                                             |
| DMS-REQ-0070 Generate PSF for Visit Images                        | Alert Production, Prompt NCSA Enclave                                                                                                                                                                                                                                                         |
| DMS-REQ-0072 Processed Visit Image Content                        | Alert Production, Prompt NCSA Enclave                                                                                                                                                                                                                                                         |
| DMS-REQ-0074 Difference Exposure Attributes                       | DBB Ingest/Metadata Management, DBB Ingest/Metadata Management SW, Alert Production, Prompt NCSA Enclave                                                                                                                                                                                      |
| DMS-REQ-0075 Catalog Queries                                      | LSP Web API, LSP Web API SW, Distributed Database, ADQL Translator, DAC Chile Enclave, DAC US Enclave                                                                                                                                                                                         |
| DMS-REQ-0077 Maintain Archive Publicly Accessible                 | DBB Ingest/Metadata Management, DBB Storage, DBB Ingest/Metadata Management SW, Distributed Database, Archive Base Enclave, Archive NCSA Enclave, DAC Chile Enclave, DAC US Enclave                                                                                                           |
| DMS-REQ-0078 Catalog Export Formats                               | LSP Web API, LSP Web API SW, ADQL Translator, Archive Base Enclave, Archive NCSA Enclave, DAC Chile Enclave, DAC US Enclave                                                                                                                                                                   |
| DMS-REQ-0089 Solar System Objects Available Within Specified Time | DBB Ingest/Metadata Management, DBB Transport/Replication/Backup, DBB Storage, LSP Web API, DBB Ingest/Metadata Management SW, DBB Transport/Replication/Backup SW, LSP Web API SW, MOPS and Forced Photometry, Archive Base Enclave, Archive NCSA Enclave, DAC Chile Enclave, DAC US Enclave |
| DMS-REQ-0094 Keep Historical Alert Archive                        | DBB Ingest/Metadata Management, DBB Storage, DBB Ingest/Metadata Management SW, Archive Base Enclave, Archive NCSA Enclave, DAC Chile Enclave, DAC US Enclave                                                                                                                                 |

| Requirement                                                            | Components                                                                                                                                                                                                                                                                                                     |
|------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| DMS-REQ-0096 Generate Data Quality Report Within Specified Time        | Prompt Quality Control, Quality Control SW, Prompt Base Enclave, Prompt NCSA Enclave                                                                                                                                                                                                                           |
| DMS-REQ-0097 Level 1 Data Quality Report Definition                    | Prompt Quality Control, Quality Control SW, Alert Production, Prompt Base Enclave, Prompt NCSA Enclave                                                                                                                                                                                                         |
| DMS-REQ-0098 Generate DMS Performance Report Within Specified Time     | Prompt Quality Control, Quality Control SW, Prompt Base Enclave, Prompt NCSA Enclave                                                                                                                                                                                                                           |
| DMS-REQ-0099 Level 1 Performance Report Definition                     | Archiving, Prompt Processing Ingest, Prompt Processing, Prompt Quality Control, Image Ingest and Processing, Quality Control SW, Prompt Base Enclave, Prompt NCSA Enclave                                                                                                                                      |
| DMS-REQ-0100 Generate Calibration Report Within Specified Time         | Prompt Quality Control, Quality Control SW, Science Plugins, Prompt Base Enclave, Prompt NCSA Enclave                                                                                                                                                                                                          |
| DMS-REQ-0101 Level 1 Calibration Report Definition                     | OCS-Driven Batch, Prompt Quality Control, OCS Batch SW, Quality Control SW, Calibration SW, Science Plugins, Prompt Base Enclave, Prompt NCSA Enclave                                                                                                                                                          |
| DMS-REQ-0102 Provide Engineering and Facility Database Archive         | Archiving, DBB Ingest/Metadata Management, DBB Transport/Replication/Backup, DBB Storage, EFD Transformation, DBB Ingest/Metadata Management SW, DBB Transport/Replication/Backup SW, Archive Base Enclave, Archive NCSA Enclave, DAC Chile Enclave, DAC US Enclave, Prompt Base Enclave, Prompt NCSA Enclave  |
| DMS-REQ-0103 Produce Images for EPO                                    | Data Release Production, Offline Production Enclave                                                                                                                                                                                                                                                            |
| DMS-REQ-0106 Coadded Image Provenance                                  | Data Release Production, Archive Base Enclave, Archive NCSA Enclave, Offline Production Enclave                                                                                                                                                                                                                |
| DMS-REQ-0119 DAC resource allocation for Level 3 processing            | LSP Portal, LSP JupyterLab, LSP Web API, SUIT, LSP JupyterLab SW, LSP Web API SW, DAC Chile Enclave, DAC US Enclave                                                                                                                                                                                            |
| DMS-REQ-0120 Level 3 Data Product Self Consistency                     | DBB Ingest/Metadata Management, LSP Web API, DBB Ingest/Metadata Management SW, LSP Web API SW, DAC Chile Enclave, DAC US Enclave                                                                                                                                                                              |
| DMS-REQ-0121 Provenance for Level 3 processing at DACs                 | LSP Web API, LSP Web API SW, Data Butler, Task Framework, DAC Chile Enclave, DAC US Enclave                                                                                                                                                                                                                    |
| DMS-REQ-0122 Access to catalogs for external Level 3 processing        | Bulk Distribution, DBB Ingest/Metadata Management, DBB Transport/Replication/Backup, DBB Storage, DBB Ingest/Metadata Management SW, DBB Transport/Replication/Backup SW                                                                                                                                       |
| DMS-REQ-0123 Access to input catalogs for DAC-based Level 3 processing | Bulk Distribution, DBB Ingest/Metadata Management, DBB Transport/Replication/Backup, DBB Storage, LSP Portal, LSP JupyterLab, LSP Web API, DBB Ingest/Metadata Management SW, DBB Transport/Replication/Backup SW, SUIT, LSP JupyterLab SW, LSP Web API SW, ADQL Translator, DAC Chile Enclave, DAC US Enclave |
| DMS-REQ-0124 Federation with external catalogs                         | LSP Portal, LSP JupyterLab, LSP Web API, SUIT, LSP JupyterLab SW, LSP Web API SW                                                                                                                                                                                                                               |
| DMS-REQ-0125 Software framework for Level 3 catalog processing         | Data Butler, Task Framework                                                                                                                                                                                                                                                                                    |

| Requirement                                                              | Components                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|--------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| DMS-REQ-0126 Access to images for external Level 3 processing            | Bulk Distribution, DBB Ingest/Metadata Management, DBB Transport/Replication/Backup, DBB Storage, DBB Ingest/Metadata Management SW, DBB Transport/Replication/Backup SW                                                                                                                                                                                                                                                                                                                             |
| DMS-REQ-0127 Access to input images for DAC-based Level 3 processing     | Bulk Distribution, DBB Ingest/Metadata Management, DBB Transport/Replication/Backup, DBB Storage, LSP Portal, LSP JupyterLab, LSP Web API, DBB Ingest/Metadata Management SW, DBB Transport/Replication/Backup SW, SUIT, LSP JupyterLab SW, LSP Web API SW, Image/Cutout Server, DAC Chile Enclave, DAC US Enclave                                                                                                                                                                                   |
| DMS-REQ-0128 Software framework for Level 3 image processing             | Data Butler, Task Framework                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| DMS-REQ-0130 Calibration Data Products                                   | DBB Ingest/Metadata Management, DBB Storage, DBB Ingest/Metadata Management SW, Science Plugins, Science Pipelines Distribution, Offline Production Enclave                                                                                                                                                                                                                                                                                                                                          |
| DMS-REQ-0131 Calibration Images Available Within Specified Time          | Prompt Processing Ingest, Prompt Processing, OCS-Driven Batch, DBB Ingest/Metadata Management, DBB Transport/Replication/Backup, DBB Storage, Image Ingest and Processing, OCS Batch SW, DBB Ingest/Metadata Management SW, DBB Transport/Replication/Backup SW, Calibration SW, Science Plugins, Archive Base Enclave, Archive NCSA Enclave, DAC Chile Enclave, DAC US Enclave, Offline Production Enclave, Prompt NCSA Enclave                                                                     |
| DMS-REQ-0132 Calibration Image Provenance                                | DBB Ingest/Metadata Management, DBB Ingest/Metadata Management SW, Science Plugins, Science Pipelines Distribution, Offline Production Enclave                                                                                                                                                                                                                                                                                                                                                       |
| DMS-REQ-0155 Provide Data Access Services                                | LSP Web API, LSP Web API SW, ADQL Translator, Image/Cutout Server                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| DMS-REQ-0156 Provide Pipeline Execution Services                         | Batch Production, Campaign Management, Workload/Workflow Management                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| DMS-REQ-0158 Provide Pipeline Construction Services                      | Task Framework                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| DMS-REQ-0160 Provide User Interface Services                             | LSP Portal, SUIT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| DMS-REQ-0161 Optimization of Cost, Reliability and Availability in Order | Alert Distribution, DBB Ingest/Metadata Management, DBB Transport/Replication/Backup, DBB Storage, LSP Portal, LSP JupyterLab, LSP Web API, Alert Distribution SW, DBB Ingest/Metadata Management SW, DBB Transport/Replication/Backup SW, SUIT, LSP JupyterLab SW, LSP Web API SW, Base Facility, NCSA Facility, Archive Base Enclave, Archive NCSA Enclave, Commissioning Cluster Enclave, DAC Chile Enclave, DAC US Enclave, Offline Production Enclave, Prompt Base Enclave, Prompt NCSA Enclave |

| Requirement                                             | Components                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|---------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| DMS-REQ-0162 Pipeline Throughput                        | Archiving, Prompt Processing Ingest, Prompt Processing, OCS-Driven Batch, Alert Distribution, DBB Ingest/Metadata Management, DBB Transport/Replication/Backup, DBB Storage, Alert Distribution SW, OCS Batch SW, DBB Ingest/Metadata Management SW, DBB Transport/Replication/Backup SW, Base Facility, NCSA Facility, Archive Base Enclave, Archive NCSA Enclave, DAC Chile Enclave, DAC US Enclave, Offline Production Enclave, Prompt Base Enclave, Prompt NCSA Enclave      |
| DMS-REQ-0163 Re-processing Capacity                     | Batch Production, DBB Ingest/Metadata Management, DBB Transport/Replication/Backup, DBB Storage, Campaign Management, Workload/Workflow Management, DBB Ingest/Metadata Management SW, DBB Transport/Replication/Backup SW, NCSA LAN Network, Base Facility, NCSA Facility, Archive Base Enclave, Archive NCSA Enclave, Offline Production Enclave                                                                                                                               |
| DMS-REQ-0164 Temporary Storage for Communications Links | DBB Ingest/Metadata Management, DBB Transport/Replication/Backup, DBB Storage, DBB Ingest/Metadata Management SW, DBB Transport/Replication/Backup SW, Base Facility, NCSA Facility, Prompt Base Enclave                                                                                                                                                                                                                                                                         |
| DMS-REQ-0165 Infrastructure Sizing for "catching up"    | Archiving, DBB Ingest/Metadata Management, DBB Transport/Replication/Backup, DBB Storage, EFD Transformation, Image Ingest and Processing, DBB Ingest/Metadata Management SW, DBB Transport/Replication/Backup SW, Summit to Base Network, Base to Archive Network, Base LAN Network, NCSA LAN Network, Base Facility, NCSA Facility, Prompt Base Enclave, Prompt NCSA Enclave                                                                                                   |
| DMS-REQ-0166 Incorporate Fault-Tolerance                | DBB Ingest/Metadata Management, DBB Transport/Replication/Backup, DBB Storage, DBB Ingest/Metadata Management SW, DBB Transport/Replication/Backup SW, Summit to Base Network, Base to Archive Network, Base LAN Network, NCSA LAN Network, Network Management, Base Facility, NCSA Facility, Archive Base Enclave, Archive NCSA Enclave, Commissioning Cluster Enclave, DAC Chile Enclave, DAC US Enclave, Offline Production Enclave, Prompt Base Enclave, Prompt NCSA Enclave |

| Requirement                                                   | Components                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|---------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| DMS-REQ-0167 Incorporate Autonomics                           | Archiving, Prompt Processing Ingest, Prompt Processing, Observatory Operations Data, Alert Distribution, Batch Production, DBB Ingest/Metadata Management, DBB Transport/Replication/Backup, DBB Storage, Alert Distribution SW, EFD Transformation, Image Ingest and Processing, Observatory Operations Data Service SW, Campaign Management, Workload-/Workflow Management, DBB Ingest/Metadata Management SW, DBB Transport/Replication/Backup SW, Summit to Base Network, Base to Archive Network, Base LAN Network, NCSA LAN Network, Network Management, Base Facility, NCSA Facility, Archive Base Enclave, Archive NCSA Enclave, Commissioning Cluster Enclave, DAC Chile Enclave, DAC US Enclave, Offline Production Enclave, Prompt Base Enclave, Prompt NCSA Enclave |
| DMS-REQ-0168 Summit Facility Data Communications              | Summit to Base Network                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| DMS-REQ-0170 Prefer Computing and Storage Down                | Base Facility, NCSA Facility                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| DMS-REQ-0171 Summit to Base Network                           | Summit to Base Network                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| DMS-REQ-0172 Summit to Base Network Availability              | Summit to Base Network                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| DMS-REQ-0173 Summit to Base Network Reliability               | Summit to Base Network                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| DMS-REQ-0174 Summit to Base Network Secondary Link            | Summit to Base Network                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| DMS-REQ-0175 Summit to Base Network Ownership and Operation   | Summit to Base Network, Network Management                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| DMS-REQ-0176 Base Facility Infrastructure                     | DBB Ingest/Metadata Management, DBB Ingest/Metadata Management SW, Base Facility, Archive Base Enclave, Commissioning Cluster Enclave, DAC Chile Enclave, Prompt Base Enclave                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| DMS-REQ-0178 Base Facility Co-Location with Existing Facility | Base Facility                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| DMS-REQ-0180 Base to Archive Network                          | Base to Archive Network                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| DMS-REQ-0181 Base to Archive Network Availability             | Base to Archive Network                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| DMS-REQ-0182 Base to Archive Network Reliability              | Base to Archive Network                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| DMS-REQ-0183 Base to Archive Network Secondary Link           | Base to Archive Network                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |

| Requirement                                                       | Components                                                                                                                                                                                                                                                                      |
|-------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| DMS-REQ-0185 Archive Center                                       | Bulk Distribution, DBB Ingest/Metadata Management, DBB Transport/Replication/Backup, DBB Storage, DBB Ingest/Metadata Management SW, DBB Transport/Replication/Backup SW, NCSA Facility, Archive NCSA Enclave, DAC US Enclave, Offline Production Enclave, Prompt NCSA Enclave  |
| DMS-REQ-0186 Archive Center Disaster Recovery                     | Bulk Distribution, DBB Ingest/Metadata Management, DBB Transport/Replication/Backup, DBB Storage, DBB Ingest/Metadata Management SW, DBB Transport/Replication/Backup SW, NCSA Facility, Archive Base Enclave, Archive NCSA Enclave, DAC US Enclave, Offline Production Enclave |
| DMS-REQ-0187 Archive Center Co-Location with Existing Facility    | NCSA Facility                                                                                                                                                                                                                                                                   |
| DMS-REQ-0188 Archive to Data Access Center Network                | Base to Archive Network, NCSA LAN Network                                                                                                                                                                                                                                       |
| DMS-REQ-0189 Archive to Data Access Center Network Availability   | Base to Archive Network, NCSA LAN Network                                                                                                                                                                                                                                       |
| DMS-REQ-0190 Archive to Data Access Center Network Reliability    | Base to Archive Network, NCSA LAN Network                                                                                                                                                                                                                                       |
| DMS-REQ-0191 Archive to Data Access Center Network Secondary Link | Base to Archive Network, NCSA LAN Network                                                                                                                                                                                                                                       |
| DMS-REQ-0193 Data Access Centers                                  | Bulk Distribution, LSP Portal, LSP JupyterLab, LSP Web API, SUIT, LSP JupyterLab SW, LSP Web API SW, Base LAN Network, NCSA LAN Network, Base Facility, NCSA Facility, DAC Chile Enclave, DAC US Enclave                                                                        |
| DMS-REQ-0194 Data Access Center Simultaneous Connections          | LSP Portal, LSP JupyterLab, LSP Web API, SUIT, LSP JupyterLab SW, LSP Web API SW, Base LAN Network, NCSA LAN Network, DAC Chile Enclave, DAC US Enclave                                                                                                                         |
| DMS-REQ-0196 Data Access Center Geographical Distribution         | Base Facility, NCSA Facility, DAC Chile Enclave, DAC US Enclave                                                                                                                                                                                                                 |
| DMS-REQ-0197 No Limit on Data Access Centers                      | DBB Ingest/Metadata Management, DBB Transport/Replication/Backup, DBB Storage, LSP Portal, LSP JupyterLab, LSP Web API, DBB Ingest/Metadata Management SW, DBB Transport/Replication/Backup SW, SUIT, LSP JupyterLab SW, LSP Web API SW                                         |
| DMS-REQ-0265 Guider Calibration Data Acquisition                  | Archiving, OCS-Driven Batch, Image Ingest and Processing, OCS Batch SW, Calibration SW, Science Plugins, Science Pipelines Distribution, Prompt Base Enclave                                                                                                                    |
| DMS-REQ-0266 Exposure Catalog                                     | DBB Ingest/Metadata Management, Header Service SW, DBB Ingest/Metadata Management SW, Alert Production, Archive Base Enclave, Archive NCSA Enclave, Prompt NCSA Enclave                                                                                                         |
| DMS-REQ-0267 Source Catalog                                       | Data Release Production, Distributed Database, Archive Base Enclave, Archive NCSA Enclave, Offline Production Enclave                                                                                                                                                           |

| Requirement                                  | Components                                                                                                                                                                                                                    |
|----------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| DMS-REQ-0268 Forced-Source Catalog           | Data Release Production, Distributed Database, Archive Base Enclave, Archive NCSA Enclave, Offline Production Enclave                                                                                                         |
| DMS-REQ-0269 DIASource Catalog               | DBB Ingest/Metadata Management, DBB Ingest/Metadata Management SW, Alert Production, Archive Base Enclave, Archive NCSA Enclave, Prompt NCSA Enclave                                                                          |
| DMS-REQ-0270 Faint DIASource Measurements    | Alert Production, Archive Base Enclave, Archive NCSA Enclave, Prompt NCSA Enclave                                                                                                                                             |
| DMS-REQ-0271 DIAObject Catalog               | DBB Ingest/Metadata Management, DBB Ingest/Metadata Management SW, Alert Production, Archive Base Enclave, Archive NCSA Enclave, Prompt NCSA Enclave                                                                          |
| DMS-REQ-0272 DIAObject Attributes            | Alert Production, Archive Base Enclave, Archive NCSA Enclave, Prompt NCSA Enclave                                                                                                                                             |
| DMS-REQ-0273 SSObject Catalog                | DBB Ingest/Metadata Management, DBB Ingest/Metadata Management SW, MOPS and Forced Photometry, Archive Base Enclave, Archive NCSA Enclave, Prompt NCSA Enclave                                                                |
| DMS-REQ-0274 Alert Content                   | Alert Production, Archive Base Enclave, Archive NCSA Enclave, Prompt NCSA Enclave                                                                                                                                             |
| DMS-REQ-0275 Object Catalog                  | Data Release Production, Distributed Database, Archive Base Enclave, Archive NCSA Enclave, Offline Production Enclave                                                                                                         |
| DMS-REQ-0276 Object Characterization         | Data Release Production, Distributed Database                                                                                                                                                                                 |
| DMS-REQ-0277 Coadd Source Catalog            | Data Release Production, Distributed Database, Offline Production Enclave                                                                                                                                                     |
| DMS-REQ-0278 Coadd Image Method Constraints  | Data Release Production, Offline Production Enclave                                                                                                                                                                           |
| DMS-REQ-0279 Deep Detection Coadds           | Data Release Production, Offline Production Enclave                                                                                                                                                                           |
| DMS-REQ-0280 Template Coadds                 | Data Release Production, Template Generation, Offline Production Enclave                                                                                                                                                      |
| DMS-REQ-0281 Multi-band Coadds               | Data Release Production, Offline Production Enclave                                                                                                                                                                           |
| DMS-REQ-0282 Dark Current Correction Frame   | Science Plugins, Science Pipelines Distribution, Offline Production Enclave                                                                                                                                                   |
| DMS-REQ-0283 Fringe Correction Frame         | Science Plugins, Science Pipelines Distribution, Offline Production Enclave                                                                                                                                                   |
| DMS-REQ-0284 Level-1 Production Completeness | Prompt Processing Ingest, Prompt Processing, Image Ingest and Processing, Archive Base Enclave, Archive NCSA Enclave, DAC Chile Enclave, DAC US Enclave, Offline Production Enclave, Prompt Base Enclave, Prompt NCSA Enclave |
| DMS-REQ-0285 Level 1 Source Association      | Alert Production                                                                                                                                                                                                              |
| DMS-REQ-0286 SSObject Precoversy             | MOPS and Forced Photometry, Offline Production Enclave                                                                                                                                                                        |

| Requirement                                         | Components                                                                                                                                                                                                                                                                                                                |
|-----------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| DMS-REQ-0287 DIASource Precovery                    | DBB Ingest/Metadata Management, DBB Transport/Replication/Backup, DBB Storage, LSP Web API, DBB Ingest/Metadata Management SW, DBB Transport/Replication/Backup SW, LSP Web API SW, MOPS and Forced Photometry, Archive Base Enclave, Archive NCSA Enclave, DAC Chile Enclave, DAC US Enclave, Offline Production Enclave |
| DMS-REQ-0288 Use of External Orbit Catalogs         | Alert Production, MOPS and Forced Photometry                                                                                                                                                                                                                                                                              |
| DMS-REQ-0289 Calibration Production Processing      | OCS-Driven Batch, OCS Batch SW, Science Plugins, Science Pipelines Distribution, Offline Production Enclave                                                                                                                                                                                                               |
| DMS-REQ-0290 Level 3 Data Import                    | LSP Web API, LSP Web API SW, Distributed Database                                                                                                                                                                                                                                                                         |
| DMS-REQ-0291 Query Repeatability                    | DBB Ingest/Metadata Management, LSP Web API, DBB Ingest/Metadata Management SW, LSP Web API SW, Distributed Database, ADQL Translator, Archive Base Enclave, Archive NCSA Enclave, DAC Chile Enclave, DAC US Enclave                                                                                                      |
| DMS-REQ-0292 Uniqueness of IDs Across Data Releases | DBB Ingest/Metadata Management, LSP Web API, DBB Ingest/Metadata Management SW, LSP Web API SW, Distributed Database                                                                                                                                                                                                      |
| DMS-REQ-0293 Selection of Datasets                  | DBB Ingest/Metadata Management, LSP Web API, DBB Ingest/Metadata Management SW, LSP Web API SW, Data Butler, Distributed Database, Image/Cutout Server                                                                                                                                                                    |
| DMS-REQ-0294 Processing of Datasets                 | Prompt Processing Ingest, Prompt Processing, OCS-Driven Batch, Batch Production, Image Ingest and Processing, OCS Batch SW, Campaign Management, Workload/Workflow Management, Task Framework                                                                                                                             |
| DMS-REQ-0295 Transparent Data Access                | LSP Web API, LSP Web API SW, Data Butler                                                                                                                                                                                                                                                                                  |
| DMS-REQ-0296 Pre-cursor, and Real Data              | Science Pipelines Libraries, Data Butler                                                                                                                                                                                                                                                                                  |
| DMS-REQ-0297 DMS Initialization Component           | Base Facility, NCSA Facility                                                                                                                                                                                                                                                                                              |
| DMS-REQ-0298 Data Product and Raw Data Access       | LSP Web API, LSP Web API SW, ADQL Translator, Image/Cutout Server                                                                                                                                                                                                                                                         |
| DMS-REQ-0299 Data Product Ingest                    | DBB Ingest/Metadata Management, DBB Ingest/Metadata Management SW, LSP Web API SW                                                                                                                                                                                                                                         |
| DMS-REQ-0300 Bulk Download Service                  | Bulk Distribution                                                                                                                                                                                                                                                                                                         |
| DMS-REQ-0301 Control of Level-1 Production          | Archiving, Prompt Processing Ingest, Prompt Processing, OCS-Driven Batch, Image Ingest and Processing, OCS Batch SW                                                                                                                                                                                                       |
| DMS-REQ-0302 Production Orchestration               | Batch Production, Campaign Management, Workload/Workflow Management                                                                                                                                                                                                                                                       |
| DMS-REQ-0303 Production Monitoring                  | Batch Production, Campaign Management, Workload/Workflow Management                                                                                                                                                                                                                                                       |
| DMS-REQ-0304 Production Fault Tolerance             | Batch Production, Campaign Management, Workload/Workflow Management, Task Framework                                                                                                                                                                                                                                       |
| DMS-REQ-0305 Task Specification                     | Task Framework                                                                                                                                                                                                                                                                                                            |
| DMS-REQ-0306 Task Configuration                     | Task Framework                                                                                                                                                                                                                                                                                                            |

| Requirement                                                   | Components                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|---------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| DMS-REQ-0307 Unique Processing Coverage                       | Batch Production                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| DMS-REQ-0308 Software Architecture to Enable Community Re-Use | Batch Production, Workload/Workflow Management, Alert Production, Calibration SW, Data Release Production, MOPS and Forced Photometry, Template Generation, Science Plugins, Science Pipelines Distribution, Science Pipelines Libraries, Data Butler, Task Framework                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| DMS-REQ-0309 Raw Data Archiving Reliability                   | Archiving, DBB Ingest/Metadata Management, DBB Transport/Replication/Backup, DBB Storage, EFD Transformation, Image Ingest and Processing, DBB Ingest/Metadata Management SW, DBB Transport/Replication/Backup SW, Archive Base Enclave, Archive NCSA Enclave, DAC Chile Enclave, DAC US Enclave, Prompt Base Enclave, Prompt NCSA Enclave                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| DMS-REQ-0310 Un-Archived Data Product Cache                   | DBB Ingest/Metadata Management, DBB Lifetime Management, DBB Storage, DBB Ingest/Metadata Management SW, DBB Lifetime Management SW, Archive Base Enclave, Archive NCSA Enclave, DAC Chile Enclave, DAC US Enclave                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| DMS-REQ-0311 Regenerate Un-archived Data Products             | LSP Web API, LSP Web API SW, Image/Cutout Server, DAC Chile Enclave, DAC US Enclave                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| DMS-REQ-0312 Level 1 Data Product Access                      | Prompt Processing, LSP Web API, LSP Web API SW, Alert Production, Archive Base Enclave, Archive NCSA Enclave, DAC Chile Enclave, DAC US Enclave                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| DMS-REQ-0313 Level 1 and 2 Catalog Access                     | DBB Ingest/Metadata Management, DBB Transport/Replication/Backup, DBB Storage, LSP Web API, DBB Ingest/Metadata Management SW, DBB Transport/Replication/Backup SW, LSP Web API SW, Distributed Database, DAC Chile Enclave, DAC US Enclave                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| DMS-REQ-0314 Compute Platform Heterogeneity                   | Archiving, Prompt Processing Ingest, Prompt Processing, Observatory Operations Data, OCS-Driven Batch, Telemetry Gateway, Alert Distribution, Prompt Quality Control, Batch Production, Bulk Distribution, DBB Ingest/Metadata Management, DBB Transport/Replication/Backup, DBB Storage, LSP Portal, LSP JupyterLab, LSP Web API, Alert Distribution SW, EFD Transformation, Image Ingest and Processing, Observatory Operations Data Service SW, OCS Batch SW, Campaign Management, Workload/Workflow Management, Quality Control SW, DBB Ingest/Metadata Management SW, DBB Transport/Replication/Backup SW, SUIT, LSP JupyterLab SW, LSP Web API SW, Data Butler, Task Framework, Base Facility, NCSA Facility, Archive Base Enclave, Archive NCSA Enclave, Commissioning Cluster Enclave, DAC Chile Enclave, DAC US Enclave, Offline Production Enclave, Prompt Base Enclave, Prompt NCSA Enclave |

| Requirement                                                               | Components                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|---------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| DMS-REQ-0315 DMS Communication with OCS                                   | Archiving, Prompt Processing Ingest, OCS-Driven Batch, Telemetry Gateway, EFD Transformation, Image Ingest and Processing, OCS Batch SW, Base Facility, Prompt Base Enclave                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| DMS-REQ-0316 Commissioning Cluster                                        | Base Facility, Commissioning Cluster Enclave                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| DMS-REQ-0317 DIAForcedSource Catalog                                      | DBB Ingest/Metadata Management, DBB Ingest/Metadata Management SW, Alert Production, MOPS and Forced Photometry, Archive Base Enclave, Archive NCSA Enclave, Prompt NCSA Enclave                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| DMS-REQ-0318 Data Management Unscheduled Downtime                         | Archiving, Prompt Processing Ingest, Prompt Processing, Observatory Operations Data, OCS-Driven Batch, Telemetry Gateway, Alert Distribution, Prompt Quality Control, Batch Production, Bulk Distribution, DBB Ingest/Metadata Management, DBB Transport/Replication/Backup, DBB Storage, LSP Portal, LSP JupyterLab, LSP Web API, Alert Distribution SW, EFD Transformation, Image Ingest and Processing, Observatory Operations Data Service SW, OCS Batch SW, Campaign Management, Workload/Workflow Management, Quality Control SW, DBB Ingest/Metadata Management SW, DBB Transport/Replication/Backup SW, SUIT, LSP JupyterLab SW, LSP Web API SW, Base Facility, NCSA Facility, Archive Base Enclave, Archive NCSA Enclave, Commissioning Cluster Enclave, DAC Chile Enclave, DAC US Enclave, Offline Production Enclave, Prompt Base Enclave, Prompt NCSA Enclave |
| DMS-REQ-0319 Characterizing Variability                                   | Alert Production, MOPS and Forced Photometry, Prompt NCSA Enclave                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| DMS-REQ-0320 Processing of Data From Special Programs                     | Data Release Production, Special Programs Productions, Task Framework, Offline Production Enclave, Prompt NCSA Enclave                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| DMS-REQ-0321 Level 1 Processing of Special Programs Data                  | Prompt Processing, Image Ingest and Processing, Alert Production, MOPS and Forced Photometry, Prompt NCSA Enclave                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| DMS-REQ-0322 Special Programs Database                                    | DBB Ingest/Metadata Management, LSP Web API, DBB Ingest/Metadata Management SW, LSP Web API SW, Special Programs Productions, Distributed Database, ADQL Translator, Archive Base Enclave, Archive NCSA Enclave, DAC Chile Enclave, DAC US Enclave                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| DMS-REQ-0323 Calculating SObject Parameters                               | LSP Web API, LSP Web API SW, ADQL Translator, DAC Chile Enclave, DAC US Enclave                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| DMS-REQ-0324 Matching DIASources to Objects                               | LSP Web API, LSP Web API SW, Alert Production, Archive Base Enclave, Archive NCSA Enclave, DAC Chile Enclave, DAC US Enclave                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| DMS-REQ-0325 Regenerating L1 Data Products During Data Release Processing | Data Release Production, Offline Production Enclave                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| DMS-REQ-0326 Storing Approximations of Per-pixel Metadata                 | Data Release Production                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

| Requirement                                                            | Components                                                                                                                                                                                                                                                                                       |
|------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| DMS-REQ-0327 Background Model Calculation                              | Alert Production, Archive Base Enclave, Archive NCSA Enclave, Prompt NCSA Enclave                                                                                                                                                                                                                |
| DMS-REQ-0328 Documenting Image Characterization                        | Alert Production, Prompt NCSA Enclave                                                                                                                                                                                                                                                            |
| DMS-REQ-0329 All-Sky Visualization of Data Releases                    | Data Release Production, Offline Production Enclave                                                                                                                                                                                                                                              |
| DMS-REQ-0330 Best Seeing Coadds                                        | Data Release Production, Offline Production Enclave                                                                                                                                                                                                                                              |
| DMS-REQ-0331 Computing Derived Quantities                              | LSP Web API, LSP Web API SW, Data Release Production, Distributed Database, ADQL Translator                                                                                                                                                                                                      |
| DMS-REQ-0332 Denormalizing Database Tables                             | LSP Web API, LSP Web API SW, Distributed Database                                                                                                                                                                                                                                                |
| DMS-REQ-0333 Maximum Likelihood Values and Covariances                 | Alert Production, Data Release Production, Distributed Database                                                                                                                                                                                                                                  |
| DMS-REQ-0334 Persisting Data Products                                  | DBB Ingest/Metadata Management, DBB Lifetime Management, DBB Storage, LSP Web API, DBB Ingest/Metadata Management SW, DBB Lifetime Management SW, LSP Web API SW, Image/Cutout Server, Archive Base Enclave, Archive NCSA Enclave, DAC Chile Enclave, DAC US Enclave, Offline Production Enclave |
| DMS-REQ-0335 PSF-Matched Coadds                                        | Data Release Production, Offline Production Enclave                                                                                                                                                                                                                                              |
| DMS-REQ-0336b Regenerating Data Products from Previous Data Releases   | LSP Web API, LSP Web API SW, Image/Cutout Server, DAC Chile Enclave, DAC US Enclave                                                                                                                                                                                                              |
| DMS-REQ-0337 Detecting faint variable objects                          | Data Release Production                                                                                                                                                                                                                                                                          |
| DMS-REQ-0338 Targeted Coadds                                           | DBB Ingest/Metadata Management, DBB Lifetime Management, DBB Storage, LSP Web API, DBB Ingest/Metadata Management SW, DBB Lifetime Management SW, LSP Web API SW, Image/Cutout Server, Archive Base Enclave, Archive NCSA Enclave, DAC Chile Enclave, DAC US Enclave                             |
| DMS-REQ-0339 Tracking Characterization Changes Between Data Releases   | DBB Ingest/Metadata Management, DBB Lifetime Management, LSP Web API, DBB Ingest/Metadata Management SW, DBB Lifetime Management SW, LSP Web API SW, Image/Cutout Server, DAC Chile Enclave, DAC US Enclave                                                                                      |
| DMS-REQ-0340 Access Controls of Level 3 Data Products                  | Distributed Database, ADQL Translator, DAC Chile Enclave, DAC US Enclave                                                                                                                                                                                                                         |
| DMS-REQ-0341 Providing a Preccovery Service                            | LSP Portal, SUIT, MOPS and Forced Photometry, DAC Chile Enclave, DAC US Enclave, Offline Production Enclave                                                                                                                                                                                      |
| DMS-REQ-0342 Alert Filtering Service                                   | Alert Distribution, Alert Distribution SW                                                                                                                                                                                                                                                        |
| DMS-REQ-0343 Performance Requirements for LSST Alert Filtering Service | Alert Distribution, Alert Distribution SW, Prompt NCSA Enclave                                                                                                                                                                                                                                   |

| Requirement                                                             | Components                                                                                                                                                                                                                                                                                                                                                   |
|-------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| DMS-REQ-0344 Constraints on Level 1 Special Program Products Generation | Prompt Processing, DBB Transport/Replication/Backup, DBB Storage, LSP Web API, Image Ingest and Processing, DBB Transport/Replication/Backup SW, LSP Web API SW, Alert Production, MOPS and Forced Photometry, Archive Base Enclave, Archive NCSA Enclave, DAC Chile Enclave, DAC US Enclave, Prompt NCSA Enclave                                            |
| DMS-REQ-0345 Logging of catalog queries                                 | LSP Web API, LSP Web API SW, Distributed Database, ADQL Translator, DAC Chile Enclave, DAC US Enclave                                                                                                                                                                                                                                                        |
| DMS-REQ-0346 Data Availability                                          | Archiving, Prompt Processing, Observatory Operations Data, Bulk Distribution, DBB Ingest/Metadata Management, DBB Lifetime Management, DBB Storage, LSP Web API, EFD Transformation, Image Ingest and Processing, Observatory Operations Data Service SW, DBB Ingest/Metadata Management SW, DBB Lifetime Management SW, LSP Web API SW, Image/Cutout Server |
| DMS-REQ-0347 Measurements in catalogs                                   | LSP Web API, LSP Web API SW, Alert Production, Data Release Production, Distributed Database                                                                                                                                                                                                                                                                 |
| DMS-REQ-0348 Pre-defined alert filters                                  | Alert Distribution, Alert Distribution SW                                                                                                                                                                                                                                                                                                                    |
| DMS-REQ-0349 Detecting extended low surface brightness objects          | Data Release Production                                                                                                                                                                                                                                                                                                                                      |
| DMS-REQ-0350 Associating Objects across data releases                   | Data Release Production, Distributed Database                                                                                                                                                                                                                                                                                                                |
| DMS-REQ-0351 Provide Beam Projector Coordinate Calculation Software     | Science Pipelines Libraries                                                                                                                                                                                                                                                                                                                                  |
| DMS-REQ-0352 Base Wireless LAN (WiFi)                                   | Base LAN Network, Base Facility                                                                                                                                                                                                                                                                                                                              |
| DMS-REQ-0353 Publishing predicted visit schedule                        | Planned Observation Publication, Planned Observation Publication SW, Prompt Base Enclave                                                                                                                                                                                                                                                                     |
| DMS-REQ-0363 Access to Previous Data Releases                           | DBB Ingest/Metadata Management, DBB Storage, LSP Portal, LSP Web API, DBB Ingest/Metadata Management SW, SUIT, LSP Web API SW, Distributed Database, Archive Base Enclave, Archive NCSA Enclave, DAC Chile Enclave, DAC US Enclave                                                                                                                           |
| DMS-REQ-0364 Data Access Services                                       | DBB Ingest/Metadata Management, DBB Storage, LSP Portal, LSP Web API, DBB Ingest/Metadata Management SW, SUIT, LSP Web API SW, ADQL Translator, Archive Base Enclave, Archive NCSA Enclave, DAC Chile Enclave, DAC US Enclave                                                                                                                                |
| DMS-REQ-0365 Operations Subsets                                         | DBB Ingest/Metadata Management, DBB Storage, LSP Portal, LSP Web API, DBB Ingest/Metadata Management SW, SUIT, LSP Web API SW, Distributed Database, Archive Base Enclave, Archive NCSA Enclave, DAC Chile Enclave, DAC US Enclave                                                                                                                           |

| Requirement                                          | Components                                                                                                                                                                                                                                                                                                |
|------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| DMS-REQ-0366 Subsets Support                         | DBB Ingest/Metadata Management, DBB Transport/Replication/Backup, DBB Storage, LSP Portal, LSP Web API, DBB Ingest/Metadata Management SW, DBB Transport/Replication/Backup SW, SUIT, LSP Web API SW, Distributed Database, Archive Base Enclave, Archive NCSA Enclave, DAC Chile Enclave, DAC US Enclave |
| DMS-REQ-0367 Access Services Performance             | DBB Storage, LSP Portal, LSP Web API, SUIT, LSP Web API SW, Distributed Database, Archive Base Enclave, Archive NCSA Enclave, DAC Chile Enclave, DAC US Enclave                                                                                                                                           |
| DMS-REQ-0368 Implementation Provisions               | DBB Storage, LSP Portal, LSP Web API, SUIT, LSP Web API SW, Distributed Database, ADQL Translator, Image/Cutout Server, Archive Base Enclave, Archive NCSA Enclave, DAC Chile Enclave, DAC US Enclave                                                                                                     |
| DMS-REQ-0369 Evolution                               | DBB Ingest/Metadata Management, LSP Portal, LSP Web API, DBB Ingest/Metadata Management SW, SUIT, LSP Web API SW, Distributed Database, ADQL Translator, Archive Base Enclave, Archive NCSA Enclave, DAC Chile Enclave, DAC US Enclave                                                                    |
| DMS-REQ-0370 Older Release Behavior                  | DBB Ingest/Metadata Management, DBB Transport/Replication/Backup, DBB Storage, LSP Portal, LSP Web API, DBB Ingest/Metadata Management SW, DBB Transport/Replication/Backup SW, SUIT, LSP Web API SW, Distributed Database, Archive Base Enclave, Archive NCSA Enclave, DAC Chile Enclave, DAC US Enclave |
| DMS-REQ-0371 Query Availability                      | LSP Portal, LSP Web API, SUIT, LSP Web API SW, Distributed Database                                                                                                                                                                                                                                       |
| DMS-REQ-0372a Archiving Camera Test Data             | DBB Ingest/Metadata Management, DBB Storage                                                                                                                                                                                                                                                               |
| DMS-REQ-0379 Produce All-Sky HiPS Map                | Data Release Production                                                                                                                                                                                                                                                                                   |
| DMS-REQ-0380 HiPS Service                            | LSP Web API                                                                                                                                                                                                                                                                                               |
| DMS-REQ-0381 HiPS Linkage to Coadds                  | LSP Web API, Data Release Production                                                                                                                                                                                                                                                                      |
| DMS-REQ-0382 HiPS Visualization                      | LSP Portal, SUIT                                                                                                                                                                                                                                                                                          |
| DMS-REQ-0383 Produce MOC Maps                        | Data Release Production                                                                                                                                                                                                                                                                                   |
| DMS-REQ-0384 Export MOCs As FITS                     | LSP Web API                                                                                                                                                                                                                                                                                               |
| DMS-REQ-0385 MOC Visualization                       | LSP Portal                                                                                                                                                                                                                                                                                                |
| DMS-REQ-0386a Archive Processing Provenance          | DBB Ingest/Metadata Management, DBB Storage, Workload/Workflow Management                                                                                                                                                                                                                                 |
| DMS-REQ-0387b Serve Archived Provenance              | DBB Ingest/Metadata Management, DBB Storage, LSP Web API                                                                                                                                                                                                                                                  |
| DMS-REQ-0388 Provide Re-Run Tools                    | Batch Production, DBB Ingest/Metadata Management, Workload/Workflow Management                                                                                                                                                                                                                            |
| DMS-REQ-0389 Re-Runs on Similar Systems              | Batch Production, Workload/Workflow Management                                                                                                                                                                                                                                                            |
| DMS-REQ-0390 Re-Runs on Other Systems                | Batch Production, Workload/Workflow Management                                                                                                                                                                                                                                                            |
| EP-DM-CON-ICD-0002 EPO is an Authorized Science User | DAC US Enclave                                                                                                                                                                                                                                                                                            |

| Requirement                                                                         | Components                                                                                                                                                   |
|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|
| EP-DM-CON-ICD-0004 DM Transfer of Catalog Data to EPO                               | Bulk Distribution                                                                                                                                            |
| EP-DM-CON-ICD-0009 Catalog Format                                                   | Bulk Distribution                                                                                                                                            |
| EP-DM-CON-ICD-0019 DM to EPO Data Transfer Cadence                                  | Bulk Distribution                                                                                                                                            |
| EP-DM-CON-ICD-0021 DM Generation of a Color Hierarchical Progressive Survey for EPO | Bulk Distribution                                                                                                                                            |
| EP-DM-CON-ICD-0034 Citizen Science Data                                             | LSP Web API, LSP Web API SW, ADQL Translator, Image/Cutout Server, DAC US Enclave                                                                            |
| EP-DM-CON-ICD-0035 DM Software                                                      | Data Butler, Task Framework                                                                                                                                  |
| EP-DM-CON-ICD-0036 DM Services                                                      | LSP Web API                                                                                                                                                  |
| EP-DM-CON-ICD-0037 EPO Compute Cluster                                              | Offline Production Enclave                                                                                                                                   |
| OCS-DM-COM-ICD-0003 Data Management CSC Command Response Model                      | Archiving, Prompt Processing Ingest, OCS-Driven Batch, EFD Transformation, Header Service SW, Image Ingest and Processing, OCS Batch SW, Prompt Base Enclave |
| OCS-DM-COM-ICD-0004 Data Management Exposed CSCs                                    | Archiving, Prompt Processing Ingest, EFD Transformation, Image Ingest and Processing, Prompt Base Enclave                                                    |
| OCS-DM-COM-ICD-0005 Main Camera Archiver                                            | Archiving, Image Ingest and Processing, Prompt Base Enclave                                                                                                  |
| OCS-DM-COM-ICD-0006 Catch-up Archiver                                               | Archiving, Image Ingest and Processing, Prompt Base Enclave                                                                                                  |
| OCS-DM-COM-ICD-0007 Prompt Processing CSC                                           | Prompt Processing Ingest, Prompt Processing, Image Ingest and Processing, Prompt Base Enclave                                                                |
| OCS-DM-COM-ICD-0008 EFD Transformation Service CSC                                  | Archiving, EFD Transformation, Prompt Base Enclave                                                                                                           |
| OCS-DM-COM-ICD-0009 Command Set Implementation by Data Management                   | Archiving, Prompt Processing Ingest, OCS-Driven Batch, Header Service SW, Image Ingest and Processing, OCS Batch SW, Prompt Base Enclave                     |
| OCS-DM-COM-ICD-0012 Start Command                                                   | Archiving, Prompt Processing Ingest, OCS-Driven Batch, Header Service SW, Image Ingest and Processing, OCS Batch SW                                          |
| OCS-DM-COM-ICD-0013 configure Successful Completion Response                        | Archiving, Prompt Processing Ingest, OCS-Driven Batch, Header Service SW, Image Ingest and Processing, OCS Batch SW                                          |
| OCS-DM-COM-ICD-0014 enable Command                                                  | Archiving, Prompt Processing Ingest, OCS-Driven Batch, Header Service SW, Image Ingest and Processing, OCS Batch SW                                          |
| OCS-DM-COM-ICD-0015 disable Command                                                 | Archiving, Prompt Processing Ingest, OCS-Driven Batch, Header Service SW, Image Ingest and Processing, OCS Batch SW                                          |
| OCS-DM-COM-ICD-0017 Data Management Telemetry Interface Model                       | Telemetry Gateway, Prompt Base Enclave                                                                                                                       |
| OCS-DM-COM-ICD-0018 Data Management Telemetry Time Stamp                            | Telemetry Gateway, Prompt Base Enclave                                                                                                                       |

| Requirement                                                                          | Components                                                                                                                   |
|--------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|
| OCS-DM-COM-ICD-0019 Data Management Events and Telemetry Required by the OCS         | Telemetry Gateway, Prompt Base Enclave                                                                                       |
| OCS-DM-COM-ICD-0020 Image and Visit Processing and Archiving Status                  | Telemetry Gateway, Prompt Base Enclave                                                                                       |
| OCS-DM-COM-ICD-0021 Data Quality Metrics                                             | Telemetry Gateway, Prompt Base Enclave                                                                                       |
| OCS-DM-COM-ICD-0022 System Health Metrics                                            | Telemetry Gateway, Prompt Base Enclave                                                                                       |
| OCS-DM-COM-ICD-0025 Expected Load of Queries from DM                                 | Archiving, EFD Transformation, Prompt Base Enclave                                                                           |
| OCS-DM-COM-ICD-0026 Engineering and Facilities Database Archiving by Data Management | Archiving, EFD Transformation, Prompt Base Enclave                                                                           |
| OCS-DM-COM-ICD-0027 Multiple Physically Separated Copies                             | Archiving, EFD Transformation, Base Facility, NCSA Facility, Archive Base Enclave, Archive NCSA Enclave, Prompt Base Enclave |
| OCS-DM-COM-ICD-0028 Expected Data Volume                                             | Archiving, EFD Transformation, Archive Base Enclave, Archive NCSA Enclave, Prompt Base Enclave                               |
| OCS-DM-COM-ICD-0029 Archive Latency                                                  | Archiving, EFD Transformation, Archive Base Enclave, Archive NCSA Enclave, DAC Chile Enclave, DAC US Enclave                 |
| OCS-DM-COM-ICD-0030 EFD Transformation Service Interface                             | Archiving, EFD Transformation, Archive Base Enclave, Archive NCSA Enclave, Prompt Base Enclave                               |
| OCS-DM-COM-ICD-0032 Auxiliary Telescope Archiver CSC                                 | Archiving, Image Ingest and Processing                                                                                       |
| OCS-DM-COM-ICD-0033 Header Service CSC                                               | Archiving, Header Service SW                                                                                                 |
| OCS-DM-COM-ICD-0034 Auxiliary Header Service CSC                                     | Archiving, Header Service SW                                                                                                 |
| OCS-DM-COM-ICD-0035 OCS-Driven Batch CSC                                             | OCS-Driven Batch, OCS Batch SW                                                                                               |
| OCS-DM-COM-ICD-0036 standby Command                                                  | Archiving, Prompt Processing Ingest, OCS-Driven Batch, Header Service SW, Image Ingest and Processing, OCS Batch SW          |
| OCS-DM-COM-ICD-0037 exit Command                                                     | Archiving, Prompt Processing Ingest, OCS-Driven Batch, Header Service SW, Image Ingest and Processing, OCS Batch SW          |
| OCS-DM-COM-ICD-0038 enterControl Command                                             | Archiving, Prompt Processing Ingest, OCS-Driven Batch, Header Service SW, Image Ingest and Processing, OCS Batch SW          |
| OCS-DM-COM-ICD-0039 enterControl Successful Completion Response                      | Archiving, Prompt Processing Ingest, OCS-Driven Batch, Header Service SW, Image Ingest and Processing, OCS Batch SW          |
| OCS-DM-COM-ICD-0040 Command Completion Response                                      | Archiving, Prompt Processing Ingest, OCS-Driven Batch, Header Service SW, Image Ingest and Processing, OCS Batch SW          |

| Requirement                                                                         | Components                                                                                  |
|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|
| OCS-DM-COM-ICD-0041 Large File Annex Replication Interface                          | Archiving                                                                                   |
| OCS-DM-COM-ICD-0042 EFD Disaster Recovery by Data Management                        | Archiving                                                                                   |
| OCS-DM-COM-ICD-0043 Image Retrieval for Archiving Event                             | Archiving, Telemetry Gateway, Image Ingest and Processing                                   |
| OCS-DM-COM-ICD-0044 Image Retrieval For Processing Event                            | Archiving, Telemetry Gateway, Image Ingest and Processing                                   |
| OCS-DM-COM-ICD-0045 Image in OODS Event                                             | Archiving, Telemetry Gateway, Image Ingest and Processing                                   |
| OCS-DM-COM-ICD-0046 Image Forwarded Event                                           | Prompt Processing Ingest, Telemetry Gateway                                                 |
| OCS-DM-COM-ICD-0047 Image Archived Event                                            | Telemetry Gateway, DBB Ingest/Metadata Management, DBB Ingest/Metadata Management SW        |
| OCS-DM-COM-ICD-0048 Alert Production Complete Event                                 | Prompt Processing, Telemetry Gateway, Alert Distribution SW                                 |
| OCS-DM-COM-ICD-0049 WCS Information                                                 | Prompt Processing, Telemetry Gateway, Alert Production                                      |
| OCS-DM-COM-ICD-0050 PSF Information                                                 | Prompt Processing, Telemetry Gateway, Alert Production                                      |
| OCS-DM-COM-ICD-0051 Photometric Zero-point Information                              | Prompt Processing, Telemetry Gateway, Alert Production                                      |
| OCS-DM-COM-ICD-0052 Number of Alerts Information                                    | Prompt Processing, Telemetry Gateway, Alert Production                                      |
| OCS-DM-COM-ICD-0053 Summit-Base Network Utilization                                 | Telemetry Gateway, Summit to Base Network                                                   |
| OCS-DM-COM-ICD-0054 Base-Archive Network Utilization                                | Telemetry Gateway, Base to Archive Network                                                  |
| OCS-DM-COM-ICD-0055 Archiver Resource Availability                                  | Archiving, Telemetry Gateway, Image Ingest and Processing                                   |
| OCS-DM-COM-ICD-0056 Prompt Processing Resource Availability                         | Prompt Processing Ingest, Prompt Processing, Telemetry Gateway, Image Ingest and Processing |
| OCS-EFD-HS-0001 Fulfill requirements of a Commandable SAL Component (CSC)           | Archiving, Header Service SW                                                                |
| OCS-EFD-HS-0002 Critical System                                                     | Archiving, Header Service SW                                                                |
| OCS-EFD-HS-0003 Write Headers for all images taken by all Cameras supported by LSST | Archiving, Header Service SW                                                                |
| OCS-EFD-HS-0004 Ability to capture metadata at the beginning of exposure            | Archiving, Header Service SW                                                                |
| OCS-EFD-HS-0005 Ability to capture metadata during of exposure integration          | Archiving, Header Service SW                                                                |
| OCS-EFD-HS-0006 Ability to capture metadata at end of readout                       | Archiving, Header Service SW                                                                |

| Requirement                                                                                        | Components                   |
|----------------------------------------------------------------------------------------------------|------------------------------|
| OCS-EFD-HS-0007 Write header and Publish Event after end of telemetry event                        | Archiving, Header Service SW |
| OCS-EFD-HS-0008 Write header and Publish Event within specified time of the end-of-telemetry Event | Archiving, Header Service SW |
| OCS-EFD-HS-0009 Adherence to the FITS Standard                                                     | Archiving, Header Service SW |
| OCS-EFD-HS-0010 Configuration of Header Keywords and source                                        | Archiving, Header Service SW |
| OCS-EFD-HS-0011 Produce header even if some meta-data not available                                | Archiving, Header Service SW |
| OCS-EFD-HS-0012 Publish an Event if monitoring detects any failure of the service.                 | Archiving, Header Service SW |
| OCS-EFD-HS-0013 Extract metadata from published configuration                                      | Archiving, Header Service SW |
| OCS-EFD-HS-0014 Metadata Capture                                                                   | Archiving, Header Service SW |
| OCS-EFD-HS-0015 Generate on-the-fly additional metadata as approved by the Project CCB.            | Archiving, Header Service SW |

## 15.2 Component to Requirement Traceability

Note that only “leaf” components are traced to requirements.

### Archiving

- CA-DM-CON-ICD-0014 Provide science sensor data
- CA-DM-CON-ICD-0015 Provide wavefront sensor data
- CA-DM-CON-ICD-0016 Provide guide sensor data
- CA-DM-CON-ICD-0017 Data Management load on image data interfaces
- CA-DM-CON-ICD-0019 Camera engineering image data archiving
- DMS-REQ-0008 Pipeline Availability
- DMS-REQ-0018 Raw Science Image Data Acquisition
- DMS-REQ-0020 Wavefront Sensor Data Acquisition
- DMS-REQ-0024 Raw Image Assembly
- DMS-REQ-0068 Raw Science Image Metadata
- DMS-REQ-0099 Level 1 Performance Report Definition
- DMS-REQ-0102 Provide Engineering and Facility Database Archive
- DMS-REQ-0162 Pipeline Throughput
- DMS-REQ-0165 Infrastructure Sizing for “catching up”
- DMS-REQ-0167 Incorporate Autonomics

- DMS-REQ-0265 Guider Calibration Data Acquisition
- DMS-REQ-0301 Control of Level-1 Production
- DMS-REQ-0309 Raw Data Archiving Reliability
- DMS-REQ-0314 Compute Platform Heterogeneity
- DMS-REQ-0315 DMS Communication with OCS
- DMS-REQ-0318 Data Management Unscheduled Downtime
- DMS-REQ-0346 Data Availability
- OCS-DM-COM-ICD-0003 Data Management CSC Command Response Model
- OCS-DM-COM-ICD-0004 Data Management Exposed CSCs
- OCS-DM-COM-ICD-0005 Main Camera Archiver
- OCS-DM-COM-ICD-0006 Catch-up Archiver
- OCS-DM-COM-ICD-0008 EFD Transformation Service CSC
- OCS-DM-COM-ICD-0009 Command Set Implementation by Data Management
- OCS-DM-COM-ICD-0012 Start Command
- OCS-DM-COM-ICD-0013 configure Successful Completion Response
- OCS-DM-COM-ICD-0014 enable Command
- OCS-DM-COM-ICD-0015 disable Command
- OCS-DM-COM-ICD-0025 Expected Load of Queries from DM
- OCS-DM-COM-ICD-0026 Engineering and Facilities Database Archiving by Data Management
- OCS-DM-COM-ICD-0027 Multiple Physically Separated Copies
- OCS-DM-COM-ICD-0028 Expected Data Volume
- OCS-DM-COM-ICD-0029 Archive Latency
- OCS-DM-COM-ICD-0030 EFD Transformation Service Interface
- OCS-DM-COM-ICD-0032 Auxiliary Telescope Archiver CSC
- OCS-DM-COM-ICD-0033 Header Service CSC
- OCS-DM-COM-ICD-0034 Auxiliary Header Service CSC
- OCS-DM-COM-ICD-0036 standby Command
- OCS-DM-COM-ICD-0037 exit Command
- OCS-DM-COM-ICD-0038 enterControl Command
- OCS-DM-COM-ICD-0039 enterControl Successful Completion Response
- OCS-DM-COM-ICD-0040 Command Completion Response
- OCS-DM-COM-ICD-0041 Large File Annex Replication Interface
- OCS-DM-COM-ICD-0042 EFD Disaster Recovery by Data Management
- OCS-DM-COM-ICD-0043 Image Retrieval for Archiving Event
- OCS-DM-COM-ICD-0044 Image Retrieval For Processing Event
- OCS-DM-COM-ICD-0045 Image in OODS Event
- OCS-DM-COM-ICD-0055 Archiver Resource Availability
- OCS-EFD-HS-0001 Fulfill requirements of a Commandable SAL Component (CSC)
- OCS-EFD-HS-0002 Critical System
- OCS-EFD-HS-0003 Write Headers for all images taken by all Cameras supported by LSST
- OCS-EFD-HS-0004 Ability to capture metadata at the beginning of exposure
- OCS-EFD-HS-0005 Ability to capture metadata during of exposure integration
- OCS-EFD-HS-0006 Ability to capture metadata at end of readout
- OCS-EFD-HS-0007 Write header and Publish Event after end of telemetry event

- OCS-EFD-HS-0008 Write header and Publish Event within specified time of the end-of-telemetry Event
- OCS-EFD-HS-0009 Adherence to the FITS Standard
- OCS-EFD-HS-0010 Configuration of Header Keywords and source
- OCS-EFD-HS-0011 Produce header even if some meta-data not available
- OCS-EFD-HS-0012 Publish an Event if monitoring detects any failure of the service.
- OCS-EFD-HS-0013 Extract metadata from published configuration
- OCS-EFD-HS-0014 Metadata Capture
- OCS-EFD-HS-0015 Generate on-the-fly additional metadata as approved by the Project CCB.

#### Planned Observation Publication

- DMS-REQ-0353 Publishing predicted visit schedule

#### Prompt Processing Ingest

- CA-DM-CON-ICD-0007 Provide Data Management Conditions data
- CA-DM-CON-ICD-0008 Data Management Conditions data latency
- CA-DM-CON-ICD-0014 Provide science sensor data
- CA-DM-CON-ICD-0015 Provide wavefront sensor data
- CA-DM-CON-ICD-0016 Provide guide sensor data
- CA-DM-CON-ICD-0017 Data Management load on image data interfaces
- DM-TS-CON-ICD-0002 Timing
- DM-TS-CON-ICD-0007 Timing
- DMS-REQ-0004 Nightly Data Accessible Within 24 hrs
- DMS-REQ-0008 Pipeline Availability
- DMS-REQ-0022 Crosstalk Corrected Science Image Data Acquisition
- DMS-REQ-0099 Level 1 Performance Report Definition
- DMS-REQ-0131 Calibration Images Available Within Specified Time
- DMS-REQ-0162 Pipeline Throughput
- DMS-REQ-0167 Incorporate Autonomics
- DMS-REQ-0284 Level-1 Production Completeness
- DMS-REQ-0294 Processing of Datasets
- DMS-REQ-0301 Control of Level-1 Production
- DMS-REQ-0314 Compute Platform Heterogeneity
- DMS-REQ-0315 DMS Communication with OCS
- DMS-REQ-0318 Data Management Unscheduled Downtime
- OCS-DM-COM-ICD-0003 Data Management CSC Command Response Model
- OCS-DM-COM-ICD-0004 Data Management Exposed CSCs
- OCS-DM-COM-ICD-0007 Prompt Processing CSC
- OCS-DM-COM-ICD-0009 Command Set Implementation by Data Management
- OCS-DM-COM-ICD-0012 Start Command
- OCS-DM-COM-ICD-0013 configure Successful Completion Response
- OCS-DM-COM-ICD-0014 enable Command

- OCS-DM-COM-ICD-0015 disable Command
- OCS-DM-COM-ICD-0036 standby Command
- OCS-DM-COM-ICD-0037 exit Command
- OCS-DM-COM-ICD-0038 enterControl Command
- OCS-DM-COM-ICD-0039 enterControl Successful Completion Response
- OCS-DM-COM-ICD-0040 Command Completion Response
- OCS-DM-COM-ICD-0046 Image Forwarded Event
- OCS-DM-COM-ICD-0056 Prompt Processing Resource Availability

#### Prompt Processing

- CA-DM-CON-ICD-0007 Provide Data Management Conditions data
- CA-DM-CON-ICD-0008 Data Management Conditions data latency
- DM-TS-CON-ICD-0002 Timing
- DM-TS-CON-ICD-0006 Data
- DM-TS-CON-ICD-0007 Timing
- DM-TS-CON-ICD-0011 Data Format
- DMS-REQ-0002 Transient Alert Distribution
- DMS-REQ-0004 Nightly Data Accessible Within 24 hrs
- DMS-REQ-0008 Pipeline Availability
- DMS-REQ-0099 Level 1 Performance Report Definition
- DMS-REQ-0131 Calibration Images Available Within Specified Time
- DMS-REQ-0162 Pipeline Throughput
- DMS-REQ-0167 Incorporate Autonomics
- DMS-REQ-0284 Level-1 Production Completeness
- DMS-REQ-0294 Processing of Datasets
- DMS-REQ-0301 Control of Level-1 Production
- DMS-REQ-0312 Level 1 Data Product Access
- DMS-REQ-0314 Compute Platform Heterogeneity
- DMS-REQ-0318 Data Management Unscheduled Downtime
- DMS-REQ-0321 Level 1 Processing of Special Programs Data
- DMS-REQ-0344 Constraints on Level 1 Special Program Products Generation
- DMS-REQ-0346 Data Availability
- OCS-DM-COM-ICD-0007 Prompt Processing CSC
- OCS-DM-COM-ICD-0048 Alert Production Complete Event
- OCS-DM-COM-ICD-0049 WCS Information
- OCS-DM-COM-ICD-0050 PSF Information
- OCS-DM-COM-ICD-0051 Photometric Zeropoint Information
- OCS-DM-COM-ICD-0052 Number of Alerts Information
- OCS-DM-COM-ICD-0056 Prompt Processing Resource Availability

#### Observatory Operations Data

- CA-DM-DAQ-ICD-0052 Correction constants for science sensors sourced by Data Management
- DM-TS-CON-ICD-0003 Wavefront image archive access
- DM-TS-CON-ICD-0009 Calibration Data Products
- DMS-REQ-0167 Incorporate Autonomics
- DMS-REQ-0314 Compute Platform Heterogeneity
- DMS-REQ-0318 Data Management Unscheduled Downtime
- DMS-REQ-0346 Data Availability

#### OCS-Driven Batch

- DMS-REQ-0008 Pipeline Availability
- DMS-REQ-0101 Level 1 Calibration Report Definition
- DMS-REQ-0131 Calibration Images Available Within Specified Time
- DMS-REQ-0162 Pipeline Throughput
- DMS-REQ-0265 Guider Calibration Data Acquisition
- DMS-REQ-0289 Calibration Production Processing
- DMS-REQ-0294 Processing of Datasets
- DMS-REQ-0301 Control of Level-1 Production
- DMS-REQ-0314 Compute Platform Heterogeneity
- DMS-REQ-0315 DMS Communication with OCS
- DMS-REQ-0318 Data Management Unscheduled Downtime
- OCS-DM-COM-ICD-0003 Data Management CSC Command Response Model
- OCS-DM-COM-ICD-0009 Command Set Implementation by Data Management
- OCS-DM-COM-ICD-0012 Start Command
- OCS-DM-COM-ICD-0013 configure Successful Completion Response
- OCS-DM-COM-ICD-0014 enable Command
- OCS-DM-COM-ICD-0015 disable Command
- OCS-DM-COM-ICD-0035 OCS-Driven Batch CSC
- OCS-DM-COM-ICD-0036 standby Command
- OCS-DM-COM-ICD-0037 exit Command
- OCS-DM-COM-ICD-0038 enterControl Command
- OCS-DM-COM-ICD-0039 enterControl Successful Completion Response
- OCS-DM-COM-ICD-0040 Command Completion Response

#### Telemetry Gateway

- CA-DM-CON-ICD-0007 Provide Data Management Conditions data
- CA-DM-CON-ICD-0008 Data Management Conditions data latency
- DM-TS-CON-ICD-0002 Timing
- DM-TS-CON-ICD-0004 Use OCS for data transport
- DM-TS-CON-ICD-0006 Data
- DM-TS-CON-ICD-0007 Timing
- DM-TS-CON-ICD-0011 Data Format

- DMS-REQ-0008 Pipeline Availability
- DMS-REQ-0314 Compute Platform Heterogeneity
- DMS-REQ-0315 DMS Communication with OCS
- DMS-REQ-0318 Data Management Unscheduled Downtime
- OCS-DM-COM-ICD-0017 Data Management Telemetry Interface Model
- OCS-DM-COM-ICD-0018 Data Management Telemetry Time Stamp
- OCS-DM-COM-ICD-0019 Data Management Events and Telemetry Required by the OCS
- OCS-DM-COM-ICD-0020 Image and Visit Processing and Archiving Status
- OCS-DM-COM-ICD-0021 Data Quality Metrics
- OCS-DM-COM-ICD-0022 System Health Metrics
- OCS-DM-COM-ICD-0043 Image Retrieval for Archiving Event
- OCS-DM-COM-ICD-0044 Image Retrieval For Processing Event
- OCS-DM-COM-ICD-0045 Image in OODS Event
- OCS-DM-COM-ICD-0046 Image Forwarded Event
- OCS-DM-COM-ICD-0047 Image Archived Event
- OCS-DM-COM-ICD-0048 Alert Production Complete Event
- OCS-DM-COM-ICD-0049 WCS Information
- OCS-DM-COM-ICD-0050 PSF Information
- OCS-DM-COM-ICD-0051 Photometric Zeropoint Information
- OCS-DM-COM-ICD-0052 Number of Alerts Information
- OCS-DM-COM-ICD-0053 Summit-Base Network Utilization
- OCS-DM-COM-ICD-0054 Base-Archive Network Utilization
- OCS-DM-COM-ICD-0055 Archiver Resource Availability
- OCS-DM-COM-ICD-0056 Prompt Processing Resource Availability

#### Alert Distribution

- DMS-REQ-0002 Transient Alert Distribution
- DMS-REQ-0004 Nightly Data Accessible Within 24 hrs
- DMS-REQ-0008 Pipeline Availability
- DMS-REQ-0161 Optimization of Cost, Reliability and Availability in Order
- DMS-REQ-0162 Pipeline Throughput
- DMS-REQ-0167 Incorporate Autonomics
- DMS-REQ-0314 Compute Platform Heterogeneity
- DMS-REQ-0318 Data Management Unscheduled Downtime
- DMS-REQ-0342 Alert Filtering Service
- DMS-REQ-0343 Performance Requirements for LSST Alert Filtering Service
- DMS-REQ-0348 Pre-defined alert filters

#### Prompt Quality Control

- DMS-REQ-0096 Generate Data Quality Report Within Specified Time
- DMS-REQ-0097 Level 1 Data Quality Report Definition

- DMS-REQ-0098 Generate DMS Performance Report Within Specified Time
- DMS-REQ-0099 Level 1 Performance Report Definition
- DMS-REQ-0100 Generate Calibration Report Within Specified Time
- DMS-REQ-0101 Level 1 Calibration Report Definition
- DMS-REQ-0314 Compute Platform Heterogeneity
- DMS-REQ-0318 Data Management Unscheduled Downtime

#### Batch Production

- DMS-REQ-0008 Pipeline Availability
- DMS-REQ-0156 Provide Pipeline Execution Services
- DMS-REQ-0163 Re-processing Capacity
- DMS-REQ-0167 Incorporate Autonomics
- DMS-REQ-0294 Processing of Datasets
- DMS-REQ-0302 Production Orchestration
- DMS-REQ-0303 Production Monitoring
- DMS-REQ-0304 Production Fault Tolerance
- DMS-REQ-0307 Unique Processing Coverage
- DMS-REQ-0308 Software Architecture to Enable Community Re-Use
- DMS-REQ-0314 Compute Platform Heterogeneity
- DMS-REQ-0318 Data Management Unscheduled Downtime
- DMS-REQ-0388 Provide Re-Run Tools
- DMS-REQ-0389 Re-Runs on Similar Systems
- DMS-REQ-0390 Re-Runs on Other Systems

#### Bulk Distribution

- DMS-REQ-0122 Access to catalogs for external Level 3 processing
- DMS-REQ-0123 Access to input catalogs for DAC-based Level 3 processing
- DMS-REQ-0126 Access to images for external Level 3 processing
- DMS-REQ-0127 Access to input images for DAC-based Level 3 processing
- DMS-REQ-0185 Archive Center
- DMS-REQ-0186 Archive Center Disaster Recovery
- DMS-REQ-0193 Data Access Centers
- DMS-REQ-0300 Bulk Download Service
- DMS-REQ-0314 Compute Platform Heterogeneity
- DMS-REQ-0318 Data Management Unscheduled Downtime
- DMS-REQ-0346 Data Availability
- EP-DM-CON-ICD-0004 DM Transfer of Catalog Data to EPO
- EP-DM-CON-ICD-0009 Catalog Format
- EP-DM-CON-ICD-0019 DM to EPO Data Transfer Cadence
- EP-DM-CON-ICD-0021 DM Generation of a Color Hierarchical Progressive Survey for EPO

## DBB Ingest/Metadata Management

- DMS-REQ-0008 Pipeline Availability
- DMS-REQ-0068 Raw Science Image Metadata
- DMS-REQ-0074 Difference Exposure Attributes
- DMS-REQ-0077 Maintain Archive Publicly Accessible
- DMS-REQ-0089 Solar System Objects Available Within Specified Time
- DMS-REQ-0094 Keep Historical Alert Archive
- DMS-REQ-0102 Provide Engineering and Facility Database Archive
- DMS-REQ-0120 Level 3 Data Product Self Consistency
- DMS-REQ-0122 Access to catalogs for external Level 3 processing
- DMS-REQ-0123 Access to input catalogs for DAC-based Level 3 processing
- DMS-REQ-0126 Access to images for external Level 3 processing
- DMS-REQ-0127 Access to input images for DAC-based Level 3 processing
- DMS-REQ-0130 Calibration Data Products
- DMS-REQ-0131 Calibration Images Available Within Specified Time
- DMS-REQ-0132 Calibration Image Provenance
- DMS-REQ-0161 Optimization of Cost, Reliability and Availability in Order
- DMS-REQ-0162 Pipeline Throughput
- DMS-REQ-0163 Re-processing Capacity
- DMS-REQ-0164 Temporary Storage for Communications Links
- DMS-REQ-0165 Infrastructure Sizing for "catching up"
- DMS-REQ-0166 Incorporate Fault-Tolerance
- DMS-REQ-0167 Incorporate Autonomics
- DMS-REQ-0176 Base Facility Infrastructure
- DMS-REQ-0185 Archive Center
- DMS-REQ-0186 Archive Center Disaster Recovery
- DMS-REQ-0197 No Limit on Data Access Centers
- DMS-REQ-0266 Exposure Catalog
- DMS-REQ-0269 DIASource Catalog
- DMS-REQ-0271 DIAObject Catalog
- DMS-REQ-0273 SSObject Catalog
- DMS-REQ-0287 DIASource Precovery
- DMS-REQ-0291 Query Repeatability
- DMS-REQ-0292 Uniqueness of IDs Across Data Releases
- DMS-REQ-0293 Selection of Datasets
- DMS-REQ-0299 Data Product Ingest
- DMS-REQ-0309 Raw Data Archiving Reliability
- DMS-REQ-0310 Un-Archived Data Product Cache
- DMS-REQ-0313 Level 1 and 2 Catalog Access
- DMS-REQ-0314 Compute Platform Heterogeneity
- DMS-REQ-0317 DIAForcedSource Catalog
- DMS-REQ-0318 Data Management Unscheduled Downtime
- DMS-REQ-0322 Special Programs Database

- DMS-REQ-0334 Persisting Data Products
- DMS-REQ-0338 Targeted Coadds
- DMS-REQ-0339 Tracking Characterization Changes Between Data Releases
- DMS-REQ-0346 Data Availability
- DMS-REQ-0363 Access to Previous Data Releases
- DMS-REQ-0364 Data Access Services
- DMS-REQ-0365 Operations Subsets
- DMS-REQ-0366 Subsets Support
- DMS-REQ-0369 Evolution
- DMS-REQ-0370 Older Release Behavior
- DMS-REQ-0372a Archiving Camera Test Data
- DMS-REQ-0386a Archive Processing Provenance
- DMS-REQ-0387b Serve Archived Provenance
- DMS-REQ-0388 Provide Re-Run Tools
- OCS-DM-COM-ICD-0047 Image Archived Event

#### DBB Lifetime Management

- DMS-REQ-0310 Un-Archived Data Product Cache
- DMS-REQ-0334 Persisting Data Products
- DMS-REQ-0338 Targeted Coadds
- DMS-REQ-0339 Tracking Characterization Changes Between Data Releases
- DMS-REQ-0346 Data Availability

#### DBB Transport/Replication/Backup

- DMS-REQ-0008 Pipeline Availability
- DMS-REQ-0089 Solar System Objects Available Within Specified Time
- DMS-REQ-0102 Provide Engineering and Facility Database Archive
- DMS-REQ-0122 Access to catalogs for external Level 3 processing
- DMS-REQ-0123 Access to input catalogs for DAC-based Level 3 processing
- DMS-REQ-0126 Access to images for external Level 3 processing
- DMS-REQ-0127 Access to input images for DAC-based Level 3 processing
- DMS-REQ-0131 Calibration Images Available Within Specified Time
- DMS-REQ-0161 Optimization of Cost, Reliability and Availability in Order
- DMS-REQ-0162 Pipeline Throughput
- DMS-REQ-0163 Re-processing Capacity
- DMS-REQ-0164 Temporary Storage for Communications Links
- DMS-REQ-0165 Infrastructure Sizing for "catching up"
- DMS-REQ-0166 Incorporate Fault-Tolerance
- DMS-REQ-0167 Incorporate Autonomics
- DMS-REQ-0185 Archive Center
- DMS-REQ-0186 Archive Center Disaster Recovery

- DMS-REQ-0197 No Limit on Data Access Centers
- DMS-REQ-0287 DIASource Precovery
- DMS-REQ-0309 Raw Data Archiving Reliability
- DMS-REQ-0313 Level 1 and 2 Catalog Access
- DMS-REQ-0314 Compute Platform Heterogeneity
- DMS-REQ-0318 Data Management Unscheduled Downtime
- DMS-REQ-0344 Constraints on Level 1 Special Program Products Generation
- DMS-REQ-0366 Subsets Support
- DMS-REQ-0370 Older Release Behavior

#### DBB Storage

- DMS-REQ-0008 Pipeline Availability
- DMS-REQ-0077 Maintain Archive Publicly Accessible
- DMS-REQ-0089 Solar System Objects Available Within Specified Time
- DMS-REQ-0094 Keep Historical Alert Archive
- DMS-REQ-0102 Provide Engineering and Facility Database Archive
- DMS-REQ-0122 Access to catalogs for external Level 3 processing
- DMS-REQ-0123 Access to input catalogs for DAC-based Level 3 processing
- DMS-REQ-0126 Access to images for external Level 3 processing
- DMS-REQ-0127 Access to input images for DAC-based Level 3 processing
- DMS-REQ-0130 Calibration Data Products
- DMS-REQ-0131 Calibration Images Available Within Specified Time
- DMS-REQ-0161 Optimization of Cost, Reliability and Availability in Order
- DMS-REQ-0162 Pipeline Throughput
- DMS-REQ-0163 Re-processing Capacity
- DMS-REQ-0164 Temporary Storage for Communications Links
- DMS-REQ-0165 Infrastructure Sizing for "catching up"
- DMS-REQ-0166 Incorporate Fault-Tolerance
- DMS-REQ-0167 Incorporate Autonomics
- DMS-REQ-0185 Archive Center
- DMS-REQ-0186 Archive Center Disaster Recovery
- DMS-REQ-0197 No Limit on Data Access Centers
- DMS-REQ-0287 DIASource Precovery
- DMS-REQ-0309 Raw Data Archiving Reliability
- DMS-REQ-0310 Un-Archived Data Product Cache
- DMS-REQ-0313 Level 1 and 2 Catalog Access
- DMS-REQ-0314 Compute Platform Heterogeneity
- DMS-REQ-0318 Data Management Unscheduled Downtime
- DMS-REQ-0334 Persisting Data Products
- DMS-REQ-0338 Targeted Coadds
- DMS-REQ-0344 Constraints on Level 1 Special Program Products Generation
- DMS-REQ-0346 Data Availability
- DMS-REQ-0363 Access to Previous Data Releases

- DMS-REQ-0364 Data Access Services
- DMS-REQ-0365 Operations Subsets
- DMS-REQ-0366 Subsets Support
- DMS-REQ-0367 Access Services Performance
- DMS-REQ-0368 Implementation Provisions
- DMS-REQ-0370 Older Release Behavior
- DMS-REQ-0372a Archiving Camera Test Data
- DMS-REQ-0386a Archive Processing Provenance
- DMS-REQ-0387b Serve Archived Provenance

#### LSP Portal

- DMS-REQ-0119 DAC resource allocation for Level 3 processing
- DMS-REQ-0123 Access to input catalogs for DAC-based Level 3 processing
- DMS-REQ-0124 Federation with external catalogs
- DMS-REQ-0127 Access to input images for DAC-based Level 3 processing
- DMS-REQ-0160 Provide User Interface Services
- DMS-REQ-0161 Optimization of Cost, Reliability and Availability in Order
- DMS-REQ-0193 Data Access Centers
- DMS-REQ-0194 Data Access Center Simultaneous Connections
- DMS-REQ-0197 No Limit on Data Access Centers
- DMS-REQ-0314 Compute Platform Heterogeneity
- DMS-REQ-0318 Data Management Unscheduled Downtime
- DMS-REQ-0341 Providing a Precovery Service
- DMS-REQ-0363 Access to Previous Data Releases
- DMS-REQ-0364 Data Access Services
- DMS-REQ-0365 Operations Subsets
- DMS-REQ-0366 Subsets Support
- DMS-REQ-0367 Access Services Performance
- DMS-REQ-0368 Implementation Provisions
- DMS-REQ-0369 Evolution
- DMS-REQ-0370 Older Release Behavior
- DMS-REQ-0371 Query Availability
- DMS-REQ-0382 HiPS Visualization
- DMS-REQ-0385 MOC Visualization

#### LSP JupyterLab

- DMS-REQ-0119 DAC resource allocation for Level 3 processing
- DMS-REQ-0123 Access to input catalogs for DAC-based Level 3 processing
- DMS-REQ-0124 Federation with external catalogs
- DMS-REQ-0127 Access to input images for DAC-based Level 3 processing
- DMS-REQ-0161 Optimization of Cost, Reliability and Availability in Order

- DMS-REQ-0193 Data Access Centers
- DMS-REQ-0194 Data Access Center Simultaneous Connections
- DMS-REQ-0197 No Limit on Data Access Centers
- DMS-REQ-0314 Compute Platform Heterogeneity
- DMS-REQ-0318 Data Management Unscheduled Downtime

#### LSP Web API

- DMS-REQ-0065 Provide Image Access Services
- DMS-REQ-0075 Catalog Queries
- DMS-REQ-0078 Catalog Export Formats
- DMS-REQ-0089 Solar System Objects Available Within Specified Time
- DMS-REQ-0119 DAC resource allocation for Level 3 processing
- DMS-REQ-0120 Level 3 Data Product Self Consistency
- DMS-REQ-0121 Provenance for Level 3 processing at DACs
- DMS-REQ-0123 Access to input catalogs for DAC-based Level 3 processing
- DMS-REQ-0124 Federation with external catalogs
- DMS-REQ-0127 Access to input images for DAC-based Level 3 processing
- DMS-REQ-0155 Provide Data Access Services
- DMS-REQ-0161 Optimization of Cost, Reliability and Availability in Order
- DMS-REQ-0193 Data Access Centers
- DMS-REQ-0194 Data Access Center Simultaneous Connections
- DMS-REQ-0197 No Limit on Data Access Centers
- DMS-REQ-0287 DIASource Precovery
- DMS-REQ-0290 Level 3 Data Import
- DMS-REQ-0291 Query Repeatability
- DMS-REQ-0292 Uniqueness of IDs Across Data Releases
- DMS-REQ-0293 Selection of Datasets
- DMS-REQ-0295 Transparent Data Access
- DMS-REQ-0298 Data Product and Raw Data Access
- DMS-REQ-0311 Regenerate Un-archived Data Products
- DMS-REQ-0312 Level 1 Data Product Access
- DMS-REQ-0313 Level 1 and 2 Catalog Access
- DMS-REQ-0314 Compute Platform Heterogeneity
- DMS-REQ-0318 Data Management Unscheduled Downtime
- DMS-REQ-0322 Special Programs Database
- DMS-REQ-0323 Calculating SSOBJECT Parameters
- DMS-REQ-0324 Matching DIASources to Objects
- DMS-REQ-0331 Computing Derived Quantities
- DMS-REQ-0332 Denormalizing Database Tables
- DMS-REQ-0334 Persisting Data Products
- DMS-REQ-0336b Regenerating Data Products from Previous Data Releases
- DMS-REQ-0338 Targeted Coadds
- DMS-REQ-0339 Tracking Characterization Changes Between Data Releases

- DMS-REQ-0344 Constraints on Level 1 Special Program Products Generation
- DMS-REQ-0345 Logging of catalog queries
- DMS-REQ-0346 Data Availability
- DMS-REQ-0347 Measurements in catalogs
- DMS-REQ-0363 Access to Previous Data Releases
- DMS-REQ-0364 Data Access Services
- DMS-REQ-0365 Operations Subsets
- DMS-REQ-0366 Subsets Support
- DMS-REQ-0367 Access Services Performance
- DMS-REQ-0368 Implementation Provisions
- DMS-REQ-0369 Evolution
- DMS-REQ-0370 Older Release Behavior
- DMS-REQ-0371 Query Availability
- DMS-REQ-0380 HiPS Service
- DMS-REQ-0381 HiPS Linkage to Coadds
- DMS-REQ-0384 Export MOCs As FITS
- DMS-REQ-0387b Serve Archived Provenance
- EP-DM-CON-ICD-0034 Citizen Science Data
- EP-DM-CON-ICD-0036 DM Services

#### Alert Distribution SW

- DMS-REQ-0002 Transient Alert Distribution
- DMS-REQ-0004 Nightly Data Accessible Within 24 hrs
- DMS-REQ-0008 Pipeline Availability
- DMS-REQ-0161 Optimization of Cost, Reliability and Availability in Order
- DMS-REQ-0162 Pipeline Throughput
- DMS-REQ-0167 Incorporate Autonomics
- DMS-REQ-0314 Compute Platform Heterogeneity
- DMS-REQ-0318 Data Management Unscheduled Downtime
- DMS-REQ-0342 Alert Filtering Service
- DMS-REQ-0343 Performance Requirements for LSST Alert Filtering Service
- DMS-REQ-0348 Pre-defined alert filters
- OCS-DM-COM-ICD-0048 Alert Production Complete Event

#### EFD Transformation

- DMS-REQ-0004 Nightly Data Accessible Within 24 hrs
- DMS-REQ-0008 Pipeline Availability
- DMS-REQ-0102 Provide Engineering and Facility Database Archive
- DMS-REQ-0165 Infrastructure Sizing for "catching up"
- DMS-REQ-0167 Incorporate Autonomics
- DMS-REQ-0309 Raw Data Archiving Reliability

- DMS-REQ-0314 Compute Platform Heterogeneity
- DMS-REQ-0315 DMS Communication with OCS
- DMS-REQ-0318 Data Management Unscheduled Downtime
- DMS-REQ-0346 Data Availability
- OCS-DM-COM-ICD-0003 Data Management CSC Command Response Model
- OCS-DM-COM-ICD-0004 Data Management Exposed CSCs
- OCS-DM-COM-ICD-0008 EFD Transformation Service CSC
- OCS-DM-COM-ICD-0025 Expected Load of Queries from DM
- OCS-DM-COM-ICD-0026 Engineering and Facilities Database Archiving by Data Management
- OCS-DM-COM-ICD-0027 Multiple Physically Separated Copies
- OCS-DM-COM-ICD-0028 Expected Data Volume
- OCS-DM-COM-ICD-0029 Archive Latency
- OCS-DM-COM-ICD-0030 EFD Transformation Service Interface

#### Header Service SW

- DMS-REQ-0266 Exposure Catalog
- OCS-DM-COM-ICD-0003 Data Management CSC Command Response Model
- OCS-DM-COM-ICD-0009 Command Set Implementation by Data Management
- OCS-DM-COM-ICD-0012 Start Command
- OCS-DM-COM-ICD-0013 configure Successful Completion Response
- OCS-DM-COM-ICD-0014 enable Command
- OCS-DM-COM-ICD-0015 disable Command
- OCS-DM-COM-ICD-0033 Header Service CSC
- OCS-DM-COM-ICD-0034 Auxiliary Header Service CSC
- OCS-DM-COM-ICD-0036 standby Command
- OCS-DM-COM-ICD-0037 exit Command
- OCS-DM-COM-ICD-0038 enterControl Command
- OCS-DM-COM-ICD-0039 enterControl Successful Completion Response
- OCS-DM-COM-ICD-0040 Command Completion Response
- OCS-EFD-HS-0001 Fulfill requirements of a Commandable SAL Component (CSC)
- OCS-EFD-HS-0002 Critical System
- OCS-EFD-HS-0003 Write Headers for all images taken by all Cameras supported by LSST
- OCS-EFD-HS-0004 Ability to capture metadata at the beginning of exposure
- OCS-EFD-HS-0005 Ability to capture metadata during of exposure integration
- OCS-EFD-HS-0006 Ability to capture metadata at end of readout
- OCS-EFD-HS-0007 Write header and Publish Event after end of telemetry event
- OCS-EFD-HS-0008 Write header and Publish Event within specified time of the end-of-telemetry Event
- OCS-EFD-HS-0009 Adherence to the FITS Standard
- OCS-EFD-HS-0010 Configuration of Header Keywords and source
- OCS-EFD-HS-0011 Produce header even if some meta-data not available
- OCS-EFD-HS-0012 Publish an Event if monitoring detects any failure of the service.
- OCS-EFD-HS-0013 Extract metadata from published configuration
- OCS-EFD-HS-0014 Metadata Capture

- OCS-EFD-HS-0015 Generate on-the-fly additional metadata as approved by the Project CCB.

## Image Ingest and Processing

- CA-DM-CON-ICD-0014 Provide science sensor data
- CA-DM-CON-ICD-0015 Provide wavefront sensor data
- CA-DM-CON-ICD-0016 Provide guide sensor data
- CA-DM-CON-ICD-0017 Data Management load on image data interfaces
- CA-DM-CON-ICD-0019 Camera engineering image data archiving
- DM-TS-CON-ICD-0002 Timing
- DM-TS-CON-ICD-0007 Timing
- DMS-REQ-0004 Nightly Data Accessible Within 24 hrs
- DMS-REQ-0008 Pipeline Availability
- DMS-REQ-0018 Raw Science Image Data Acquisition
- DMS-REQ-0020 Wavefront Sensor Data Acquisition
- DMS-REQ-0022 Crosstalk Corrected Science Image Data Acquisition
- DMS-REQ-0024 Raw Image Assembly
- DMS-REQ-0068 Raw Science Image Metadata
- DMS-REQ-0099 Level 1 Performance Report Definition
- DMS-REQ-0131 Calibration Images Available Within Specified Time
- DMS-REQ-0165 Infrastructure Sizing for "catching up"
- DMS-REQ-0167 Incorporate Autonomics
- DMS-REQ-0265 Guider Calibration Data Acquisition
- DMS-REQ-0284 Level-1 Production Completeness
- DMS-REQ-0294 Processing of Datasets
- DMS-REQ-0301 Control of Level-1 Production
- DMS-REQ-0309 Raw Data Archiving Reliability
- DMS-REQ-0314 Compute Platform Heterogeneity
- DMS-REQ-0315 DMS Communication with OCS
- DMS-REQ-0318 Data Management Unscheduled Downtime
- DMS-REQ-0321 Level 1 Processing of Special Programs Data
- DMS-REQ-0344 Constraints on Level 1 Special Program Products Generation
- DMS-REQ-0346 Data Availability
- OCS-DM-COM-ICD-0003 Data Management CSC Command Response Model
- OCS-DM-COM-ICD-0004 Data Management Exposed CSCs
- OCS-DM-COM-ICD-0005 Main Camera Archiver
- OCS-DM-COM-ICD-0006 Catch-up Archiver
- OCS-DM-COM-ICD-0007 Prompt Processing CSC
- OCS-DM-COM-ICD-0009 Command Set Implementation by Data Management
- OCS-DM-COM-ICD-0012 Start Command
- OCS-DM-COM-ICD-0013 configure Successful Completion Response
- OCS-DM-COM-ICD-0014 enable Command
- OCS-DM-COM-ICD-0015 disable Command
- OCS-DM-COM-ICD-0032 Auxiliary Telescope Archiver CSC

- OCS-DM-COM-ICD-0036 standby Command
- OCS-DM-COM-ICD-0037 exit Command
- OCS-DM-COM-ICD-0038 enterControl Command
- OCS-DM-COM-ICD-0039 enterControl Successful Completion Response
- OCS-DM-COM-ICD-0040 Command Completion Response
- OCS-DM-COM-ICD-0043 Image Retrieval for Archiving Event
- OCS-DM-COM-ICD-0044 Image Retrieval For Processing Event
- OCS-DM-COM-ICD-0045 Image in OODS Event
- OCS-DM-COM-ICD-0055 Archiver Resource Availability
- OCS-DM-COM-ICD-0056 Prompt Processing Resource Availability

#### Observatory Operations Data Service SW

- CA-DM-DAQ-ICD-0052 Correction constants for science sensors sourced by Data Management
- DM-TS-CON-ICD-0003 Wavefront image archive access
- DMS-REQ-0167 Incorporate Autonomics
- DMS-REQ-0314 Compute Platform Heterogeneity
- DMS-REQ-0318 Data Management Unscheduled Downtime
- DMS-REQ-0346 Data Availability

#### OCS Batch SW

- DMS-REQ-0008 Pipeline Availability
- DMS-REQ-0101 Level 1 Calibration Report Definition
- DMS-REQ-0131 Calibration Images Available Within Specified Time
- DMS-REQ-0162 Pipeline Throughput
- DMS-REQ-0265 Guider Calibration Data Acquisition
- DMS-REQ-0289 Calibration Production Processing
- DMS-REQ-0294 Processing of Datasets
- DMS-REQ-0301 Control of Level-1 Production
- DMS-REQ-0314 Compute Platform Heterogeneity
- DMS-REQ-0315 DMS Communication with OCS
- DMS-REQ-0318 Data Management Unscheduled Downtime
- OCS-DM-COM-ICD-0003 Data Management CSC Command Response Model
- OCS-DM-COM-ICD-0009 Command Set Implementation by Data Management
- OCS-DM-COM-ICD-0012 Start Command
- OCS-DM-COM-ICD-0013 configure Successful Completion Response
- OCS-DM-COM-ICD-0014 enable Command
- OCS-DM-COM-ICD-0015 disable Command
- OCS-DM-COM-ICD-0035 OCS-Driven Batch CSC
- OCS-DM-COM-ICD-0036 standby Command
- OCS-DM-COM-ICD-0037 exit Command
- OCS-DM-COM-ICD-0038 enterControl Command

- OCS-DM-COM-ICD-0039 enterControl Successful Completion Response
- OCS-DM-COM-ICD-0040 Command Completion Response

#### Planned Observation Publication SW

- DMS-REQ-0353 Publishing predicted visit schedule

#### Campaign Management

- DMS-REQ-0008 Pipeline Availability
- DMS-REQ-0156 Provide Pipeline Execution Services
- DMS-REQ-0163 Re-processing Capacity
- DMS-REQ-0167 Incorporate Autonomics
- DMS-REQ-0294 Processing of Datasets
- DMS-REQ-0302 Production Orchestration
- DMS-REQ-0303 Production Monitoring
- DMS-REQ-0304 Production Fault Tolerance
- DMS-REQ-0314 Compute Platform Heterogeneity
- DMS-REQ-0318 Data Management Unscheduled Downtime

#### Workload/Workflow Management

- DMS-REQ-0008 Pipeline Availability
- DMS-REQ-0156 Provide Pipeline Execution Services
- DMS-REQ-0163 Re-processing Capacity
- DMS-REQ-0167 Incorporate Autonomics
- DMS-REQ-0294 Processing of Datasets
- DMS-REQ-0302 Production Orchestration
- DMS-REQ-0303 Production Monitoring
- DMS-REQ-0304 Production Fault Tolerance
- DMS-REQ-0308 Software Architecture to Enable Community Re-Use
- DMS-REQ-0314 Compute Platform Heterogeneity
- DMS-REQ-0318 Data Management Unscheduled Downtime
- DMS-REQ-0386a Archive Processing Provenance
- DMS-REQ-0388 Provide Re-Run Tools
- DMS-REQ-0389 Re-Runs on Similar Systems
- DMS-REQ-0390 Re-Runs on Other Systems

#### Quality Control SW

- DMS-REQ-0096 Generate Data Quality Report Within Specified Time
- DMS-REQ-0097 Level 1 Data Quality Report Definition

- DMS-REQ-0098 Generate DMS Performance Report Within Specified Time
- DMS-REQ-0099 Level 1 Performance Report Definition
- DMS-REQ-0100 Generate Calibration Report Within Specified Time
- DMS-REQ-0101 Level 1 Calibration Report Definition
- DMS-REQ-0314 Compute Platform Heterogeneity
- DMS-REQ-0318 Data Management Unscheduled Downtime

#### DBB Ingest/Metadata Management SW

- DMS-REQ-0008 Pipeline Availability
- DMS-REQ-0068 Raw Science Image Metadata
- DMS-REQ-0074 Difference Exposure Attributes
- DMS-REQ-0077 Maintain Archive Publicly Accessible
- DMS-REQ-0089 Solar System Objects Available Within Specified Time
- DMS-REQ-0094 Keep Historical Alert Archive
- DMS-REQ-0102 Provide Engineering and Facility Database Archive
- DMS-REQ-0120 Level 3 Data Product Self Consistency
- DMS-REQ-0122 Access to catalogs for external Level 3 processing
- DMS-REQ-0123 Access to input catalogs for DAC-based Level 3 processing
- DMS-REQ-0126 Access to images for external Level 3 processing
- DMS-REQ-0127 Access to input images for DAC-based Level 3 processing
- DMS-REQ-0130 Calibration Data Products
- DMS-REQ-0131 Calibration Images Available Within Specified Time
- DMS-REQ-0132 Calibration Image Provenance
- DMS-REQ-0161 Optimization of Cost, Reliability and Availability in Order
- DMS-REQ-0162 Pipeline Throughput
- DMS-REQ-0163 Re-processing Capacity
- DMS-REQ-0164 Temporary Storage for Communications Links
- DMS-REQ-0165 Infrastructure Sizing for "catching up"
- DMS-REQ-0166 Incorporate Fault-Tolerance
- DMS-REQ-0167 Incorporate Autonomics
- DMS-REQ-0176 Base Facility Infrastructure
- DMS-REQ-0185 Archive Center
- DMS-REQ-0186 Archive Center Disaster Recovery
- DMS-REQ-0197 No Limit on Data Access Centers
- DMS-REQ-0266 Exposure Catalog
- DMS-REQ-0269 DIASource Catalog
- DMS-REQ-0271 DIAObject Catalog
- DMS-REQ-0273 SSObject Catalog
- DMS-REQ-0287 DIASource Precoversy
- DMS-REQ-0291 Query Repeatability
- DMS-REQ-0292 Uniqueness of IDs Across Data Releases
- DMS-REQ-0293 Selection of Datasets
- DMS-REQ-0299 Data Product Ingest

- DMS-REQ-0309 Raw Data Archiving Reliability
- DMS-REQ-0310 Un-Archived Data Product Cache
- DMS-REQ-0313 Level 1 and 2 Catalog Access
- DMS-REQ-0314 Compute Platform Heterogeneity
- DMS-REQ-0317 DIAForcedSource Catalog
- DMS-REQ-0318 Data Management Unscheduled Downtime
- DMS-REQ-0322 Special Programs Database
- DMS-REQ-0334 Persisting Data Products
- DMS-REQ-0338 Targeted Coadds
- DMS-REQ-0339 Tracking Characterization Changes Between Data Releases
- DMS-REQ-0346 Data Availability
- DMS-REQ-0363 Access to Previous Data Releases
- DMS-REQ-0364 Data Access Services
- DMS-REQ-0365 Operations Subsets
- DMS-REQ-0366 Subsets Support
- DMS-REQ-0369 Evolution
- DMS-REQ-0370 Older Release Behavior
- OCS-DM-COM-ICD-0047 Image Archived Event

#### DBB Lifetime Management SW

- DMS-REQ-0310 Un-Archived Data Product Cache
- DMS-REQ-0334 Persisting Data Products
- DMS-REQ-0338 Targeted Coadds
- DMS-REQ-0339 Tracking Characterization Changes Between Data Releases
- DMS-REQ-0346 Data Availability

#### DBB Transport/Replication/Backup SW

- DMS-REQ-0008 Pipeline Availability
- DMS-REQ-0089 Solar System Objects Available Within Specified Time
- DMS-REQ-0102 Provide Engineering and Facility Database Archive
- DMS-REQ-0122 Access to catalogs for external Level 3 processing
- DMS-REQ-0123 Access to input catalogs for DAC-based Level 3 processing
- DMS-REQ-0126 Access to images for external Level 3 processing
- DMS-REQ-0127 Access to input images for DAC-based Level 3 processing
- DMS-REQ-0131 Calibration Images Available Within Specified Time
- DMS-REQ-0161 Optimization of Cost, Reliability and Availability in Order
- DMS-REQ-0162 Pipeline Throughput
- DMS-REQ-0163 Re-processing Capacity
- DMS-REQ-0164 Temporary Storage for Communications Links
- DMS-REQ-0165 Infrastructure Sizing for "catching up"
- DMS-REQ-0166 Incorporate Fault-Tolerance

- DMS-REQ-0167 Incorporate Autonomics
- DMS-REQ-0185 Archive Center
- DMS-REQ-0186 Archive Center Disaster Recovery
- DMS-REQ-0197 No Limit on Data Access Centers
- DMS-REQ-0287 DIASource Precovery
- DMS-REQ-0309 Raw Data Archiving Reliability
- DMS-REQ-0313 Level 1 and 2 Catalog Access
- DMS-REQ-0314 Compute Platform Heterogeneity
- DMS-REQ-0318 Data Management Unscheduled Downtime
- DMS-REQ-0344 Constraints on Level 1 Special Program Products Generation
- DMS-REQ-0366 Subsets Support
- DMS-REQ-0370 Older Release Behavior

## SUIT

- DMS-REQ-0119 DAC resource allocation for Level 3 processing
- DMS-REQ-0123 Access to input catalogs for DAC-based Level 3 processing
- DMS-REQ-0124 Federation with external catalogs
- DMS-REQ-0127 Access to input images for DAC-based Level 3 processing
- DMS-REQ-0160 Provide User Interface Services
- DMS-REQ-0161 Optimization of Cost, Reliability and Availability in Order
- DMS-REQ-0193 Data Access Centers
- DMS-REQ-0194 Data Access Center Simultaneous Connections
- DMS-REQ-0197 No Limit on Data Access Centers
- DMS-REQ-0314 Compute Platform Heterogeneity
- DMS-REQ-0318 Data Management Unscheduled Downtime
- DMS-REQ-0341 Providing a Precovery Service
- DMS-REQ-0363 Access to Previous Data Releases
- DMS-REQ-0364 Data Access Services
- DMS-REQ-0365 Operations Subsets
- DMS-REQ-0366 Subsets Support
- DMS-REQ-0367 Access Services Performance
- DMS-REQ-0368 Implementation Provisions
- DMS-REQ-0369 Evolution
- DMS-REQ-0370 Older Release Behavior
- DMS-REQ-0371 Query Availability
- DMS-REQ-0382 HiPS Visualization

## LSP JupyterLab SW

- DMS-REQ-0119 DAC resource allocation for Level 3 processing
- DMS-REQ-0123 Access to input catalogs for DAC-based Level 3 processing
- DMS-REQ-0124 Federation with external catalogs

- DMS-REQ-0127 Access to input images for DAC-based Level 3 processing
- DMS-REQ-0161 Optimization of Cost, Reliability and Availability in Order
- DMS-REQ-0193 Data Access Centers
- DMS-REQ-0194 Data Access Center Simultaneous Connections
- DMS-REQ-0197 No Limit on Data Access Centers
- DMS-REQ-0314 Compute Platform Heterogeneity
- DMS-REQ-0318 Data Management Unscheduled Downtime

#### LSP Web API SW

- DMS-REQ-0065 Provide Image Access Services
- DMS-REQ-0075 Catalog Queries
- DMS-REQ-0078 Catalog Export Formats
- DMS-REQ-0089 Solar System Objects Available Within Specified Time
- DMS-REQ-0119 DAC resource allocation for Level 3 processing
- DMS-REQ-0120 Level 3 Data Product Self Consistency
- DMS-REQ-0121 Provenance for Level 3 processing at DACs
- DMS-REQ-0123 Access to input catalogs for DAC-based Level 3 processing
- DMS-REQ-0124 Federation with external catalogs
- DMS-REQ-0127 Access to input images for DAC-based Level 3 processing
- DMS-REQ-0155 Provide Data Access Services
- DMS-REQ-0161 Optimization of Cost, Reliability and Availability in Order
- DMS-REQ-0193 Data Access Centers
- DMS-REQ-0194 Data Access Center Simultaneous Connections
- DMS-REQ-0197 No Limit on Data Access Centers
- DMS-REQ-0287 DIASource Precovery
- DMS-REQ-0290 Level 3 Data Import
- DMS-REQ-0291 Query Repeatability
- DMS-REQ-0292 Uniqueness of IDs Across Data Releases
- DMS-REQ-0293 Selection of Datasets
- DMS-REQ-0295 Transparent Data Access
- DMS-REQ-0298 Data Product and Raw Data Access
- DMS-REQ-0299 Data Product Ingest
- DMS-REQ-0311 Regenerate Un-archived Data Products
- DMS-REQ-0312 Level 1 Data Product Access
- DMS-REQ-0313 Level 1 and 2 Catalog Access
- DMS-REQ-0314 Compute Platform Heterogeneity
- DMS-REQ-0318 Data Management Unscheduled Downtime
- DMS-REQ-0322 Special Programs Database
- DMS-REQ-0323 Calculating SSObject Parameters
- DMS-REQ-0324 Matching DIASources to Objects
- DMS-REQ-0331 Computing Derived Quantities
- DMS-REQ-0332 Denormalizing Database Tables
- DMS-REQ-0334 Persisting Data Products

- DMS-REQ-0336b Regenerating Data Products from Previous Data Releases
- DMS-REQ-0338 Targeted Coadds
- DMS-REQ-0339 Tracking Characterization Changes Between Data Releases
- DMS-REQ-0344 Constraints on Level 1 Special Program Products Generation
- DMS-REQ-0345 Logging of catalog queries
- DMS-REQ-0346 Data Availability
- DMS-REQ-0347 Measurements in catalogs
- DMS-REQ-0363 Access to Previous Data Releases
- DMS-REQ-0364 Data Access Services
- DMS-REQ-0365 Operations Subsets
- DMS-REQ-0366 Subsets Support
- DMS-REQ-0367 Access Services Performance
- DMS-REQ-0368 Implementation Provisions
- DMS-REQ-0369 Evolution
- DMS-REQ-0370 Older Release Behavior
- DMS-REQ-0371 Query Availability
- EP-DM-CON-ICD-0034 Citizen Science Data

#### Alert Production

- DMS-REQ-0002 Transient Alert Distribution
- DMS-REQ-0004 Nightly Data Accessible Within 24 hrs
- DMS-REQ-0009 Simulated Data
- DMS-REQ-0010 Difference Exposures
- DMS-REQ-0029 Generate Photometric Zeropoint for Visit Image
- DMS-REQ-0030 Generate WCS for Visit Images
- DMS-REQ-0032 Image Differencing
- DMS-REQ-0033 Provide Source Detection Software
- DMS-REQ-0042 Provide Astrometric Model
- DMS-REQ-0043 Provide Calibrated Photometry
- DMS-REQ-0052 Enable a Range of Shape Measurement Approaches
- DMS-REQ-0069 Processed Visit Images
- DMS-REQ-0070 Generate PSF for Visit Images
- DMS-REQ-0072 Processed Visit Image Content
- DMS-REQ-0074 Difference Exposure Attributes
- DMS-REQ-0097 Level 1 Data Quality Report Definition
- DMS-REQ-0266 Exposure Catalog
- DMS-REQ-0269 DIASource Catalog
- DMS-REQ-0270 Faint DIASource Measurements
- DMS-REQ-0271 DIAObject Catalog
- DMS-REQ-0272 DIAObject Attributes
- DMS-REQ-0274 Alert Content
- DMS-REQ-0285 Level 1 Source Association
- DMS-REQ-0288 Use of External Orbit Catalogs

- DMS-REQ-0308 Software Architecture to Enable Community Re-Use
- DMS-REQ-0312 Level 1 Data Product Access
- DMS-REQ-0317 DIAForcedSource Catalog
- DMS-REQ-0319 Characterizing Variability
- DMS-REQ-0321 Level 1 Processing of Special Programs Data
- DMS-REQ-0324 Matching DIASources to Objects
- DMS-REQ-0327 Background Model Calculation
- DMS-REQ-0328 Documenting Image Characterization
- DMS-REQ-0333 Maximum Likelihood Values and Covariances
- DMS-REQ-0344 Constraints on Level 1 Special Program Products Generation
- DMS-REQ-0347 Measurements in catalogs
- OCS-DM-COM-ICD-0049 WCS Information
- OCS-DM-COM-ICD-0050 PSF Information
- OCS-DM-COM-ICD-0051 Photometric Zeropoint Information
- OCS-DM-COM-ICD-0052 Number of Alerts Information

#### Calibration SW

- DMS-REQ-0101 Level 1 Calibration Report Definition
- DMS-REQ-0131 Calibration Images Available Within Specified Time
- DMS-REQ-0265 Guider Calibration Data Acquisition
- DMS-REQ-0308 Software Architecture to Enable Community Re-Use

#### Data Release Production

- DMS-REQ-0009 Simulated Data
- DMS-REQ-0032 Image Differencing
- DMS-REQ-0033 Provide Source Detection Software
- DMS-REQ-0034 Associate Sources to Objects
- DMS-REQ-0042 Provide Astrometric Model
- DMS-REQ-0043 Provide Calibrated Photometry
- DMS-REQ-0046 Provide Photometric Redshifts of Galaxies
- DMS-REQ-0047 Provide PSF for Coadded Images
- DMS-REQ-0052 Enable a Range of Shape Measurement Approaches
- DMS-REQ-0103 Produce Images for EPO
- DMS-REQ-0106 Coadded Image Provenance
- DMS-REQ-0267 Source Catalog
- DMS-REQ-0268 Forced-Source Catalog
- DMS-REQ-0275 Object Catalog
- DMS-REQ-0276 Object Characterization
- DMS-REQ-0277 Coadd Source Catalog
- DMS-REQ-0278 Coadd Image Method Constraints
- DMS-REQ-0279 Deep Detection Coadds

- DMS-REQ-0280 Template Coadds
- DMS-REQ-0281 Multi-band Coadds
- DMS-REQ-0308 Software Architecture to Enable Community Re-Use
- DMS-REQ-0320 Processing of Data From Special Programs
- DMS-REQ-0325 Regenerating L1 Data Products During Data Release Processing
- DMS-REQ-0326 Storing Approximations of Per-pixel Metadata
- DMS-REQ-0329 All-Sky Visualization of Data Releases
- DMS-REQ-0330 Best Seeing Coadds
- DMS-REQ-0331 Computing Derived Quantities
- DMS-REQ-0333 Maximum Likelihood Values and Covariances
- DMS-REQ-0335 PSF-Matched Coadds
- DMS-REQ-0337 Detecting faint variable objects
- DMS-REQ-0347 Measurements in catalogs
- DMS-REQ-0349 Detecting extended low surface brightness objects
- DMS-REQ-0350 Associating Objects across data releases
- DMS-REQ-0379 Produce All-Sky HiPS Map
- DMS-REQ-0381 HiPS Linkage to Coadds
- DMS-REQ-0383 Produce MOC Maps

#### MOPS and Forced Photometry

- DMS-REQ-0004 Nightly Data Accessible Within 24 hrs
- DMS-REQ-0089 Solar System Objects Available Within Specified Time
- DMS-REQ-0273 SSObject Catalog
- DMS-REQ-0286 SSObject Preccovery
- DMS-REQ-0287 DIASource Preccovery
- DMS-REQ-0288 Use of External Orbit Catalogs
- DMS-REQ-0308 Software Architecture to Enable Community Re-Use
- DMS-REQ-0317 DIAForcedSource Catalog
- DMS-REQ-0319 Characterizing Variability
- DMS-REQ-0321 Level 1 Processing of Special Programs Data
- DMS-REQ-0341 Providing a Preccovery Service
- DMS-REQ-0344 Constraints on Level 1 Special Program Products Generation

#### Special Programs Productions

- DMS-REQ-0320 Processing of Data From Special Programs
- DMS-REQ-0322 Special Programs Database

#### Template Generation

- DMS-REQ-0280 Template Coadds
- DMS-REQ-0308 Software Architecture to Enable Community Re-Use

## Science Plugins

- DMS-REQ-0059 Bad Pixel Map
- DMS-REQ-0060 Bias Residual Image
- DMS-REQ-0061 Crosstalk Correction Matrix
- DMS-REQ-0062 Illumination Correction Frame
- DMS-REQ-0063 Monochromatic Flatfield Data Cube
- DMS-REQ-0100 Generate Calibration Report Within Specified Time
- DMS-REQ-0101 Level 1 Calibration Report Definition
- DMS-REQ-0130 Calibration Data Products
- DMS-REQ-0131 Calibration Images Available Within Specified Time
- DMS-REQ-0132 Calibration Image Provenance
- DMS-REQ-0265 Guider Calibration Data Acquisition
- DMS-REQ-0282 Dark Current Correction Frame
- DMS-REQ-0283 Fringe Correction Frame
- DMS-REQ-0289 Calibration Production Processing
- DMS-REQ-0308 Software Architecture to Enable Community Re-Use

## Science Pipelines Distribution

- CA-DM-DAQ-ICD-0052 Correction constants for science sensors sourced by Data Management
- DMS-REQ-0059 Bad Pixel Map
- DMS-REQ-0060 Bias Residual Image
- DMS-REQ-0061 Crosstalk Correction Matrix
- DMS-REQ-0062 Illumination Correction Frame
- DMS-REQ-0063 Monochromatic Flatfield Data Cube
- DMS-REQ-0130 Calibration Data Products
- DMS-REQ-0132 Calibration Image Provenance
- DMS-REQ-0265 Guider Calibration Data Acquisition
- DMS-REQ-0282 Dark Current Correction Frame
- DMS-REQ-0283 Fringe Correction Frame
- DMS-REQ-0289 Calibration Production Processing
- DMS-REQ-0308 Software Architecture to Enable Community Re-Use

## Science Pipelines Libraries

- DM-TS-CON-ICD-0008 LSST Stack Availability
- DMS-REQ-0032 Image Differencing
- DMS-REQ-0033 Provide Source Detection Software
- DMS-REQ-0042 Provide Astrometric Model
- DMS-REQ-0043 Provide Calibrated Photometry
- DMS-REQ-0052 Enable a Range of Shape Measurement Approaches
- DMS-REQ-0296 Pre-cursor, and Real Data

- DMS-REQ-0308 Software Architecture to Enable Community Re-Use
- DMS-REQ-0351 Provide Beam Projector Coordinate Calculation Software

#### Data Butler

- DMS-REQ-0121 Provenance for Level 3 processing at DACs
- DMS-REQ-0125 Software framework for Level 3 catalog processing
- DMS-REQ-0128 Software framework for Level 3 image processing
- DMS-REQ-0293 Selection of Datasets
- DMS-REQ-0295 Transparent Data Access
- DMS-REQ-0296 Pre-cursor, and Real Data
- DMS-REQ-0308 Software Architecture to Enable Community Re-Use
- DMS-REQ-0314 Compute Platform Heterogeneity
- EP-DM-CON-ICD-0035 DM Software

#### Task Framework

- DMS-REQ-0121 Provenance for Level 3 processing at DACs
- DMS-REQ-0125 Software framework for Level 3 catalog processing
- DMS-REQ-0128 Software framework for Level 3 image processing
- DMS-REQ-0158 Provide Pipeline Construction Services
- DMS-REQ-0294 Processing of Datasets
- DMS-REQ-0304 Production Fault Tolerance
- DMS-REQ-0305 Task Specification
- DMS-REQ-0306 Task Configuration
- DMS-REQ-0308 Software Architecture to Enable Community Re-Use
- DMS-REQ-0314 Compute Platform Heterogeneity
- DMS-REQ-0320 Processing of Data From Special Programs
- EP-DM-CON-ICD-0035 DM Software

#### Distributed Database

- DMS-REQ-0046 Provide Photometric Redshifts of Galaxies
- DMS-REQ-0075 Catalog Queries
- DMS-REQ-0077 Maintain Archive Publicly Accessible
- DMS-REQ-0267 Source Catalog
- DMS-REQ-0268 Forced-Source Catalog
- DMS-REQ-0275 Object Catalog
- DMS-REQ-0276 Object Characterization
- DMS-REQ-0277 Coadd Source Catalog
- DMS-REQ-0290 Level 3 Data Import
- DMS-REQ-0291 Query Repeatability
- DMS-REQ-0292 Uniqueness of IDs Across Data Releases

- DMS-REQ-0293 Selection of Datasets
- DMS-REQ-0313 Level 1 and 2 Catalog Access
- DMS-REQ-0322 Special Programs Database
- DMS-REQ-0331 Computing Derived Quantities
- DMS-REQ-0332 Denormalizing Database Tables
- DMS-REQ-0333 Maximum Likelihood Values and Covariances
- DMS-REQ-0340 Access Controls of Level 3 Data Products
- DMS-REQ-0345 Logging of catalog queries
- DMS-REQ-0347 Measurements in catalogs
- DMS-REQ-0350 Associating Objects across data releases
- DMS-REQ-0363 Access to Previous Data Releases
- DMS-REQ-0365 Operations Subsets
- DMS-REQ-0366 Subsets Support
- DMS-REQ-0367 Access Services Performance
- DMS-REQ-0368 Implementation Provisions
- DMS-REQ-0369 Evolution
- DMS-REQ-0370 Older Release Behavior
- DMS-REQ-0371 Query Availability

#### ADQL Translator

- DMS-REQ-0075 Catalog Queries
- DMS-REQ-0078 Catalog Export Formats
- DMS-REQ-0123 Access to input catalogs for DAC-based Level 3 processing
- DMS-REQ-0155 Provide Data Access Services
- DMS-REQ-0291 Query Repeatability
- DMS-REQ-0298 Data Product and Raw Data Access
- DMS-REQ-0322 Special Programs Database
- DMS-REQ-0323 Calculating SSOBJECT Parameters
- DMS-REQ-0331 Computing Derived Quantities
- DMS-REQ-0340 Access Controls of Level 3 Data Products
- DMS-REQ-0345 Logging of catalog queries
- DMS-REQ-0364 Data Access Services
- DMS-REQ-0368 Implementation Provisions
- DMS-REQ-0369 Evolution
- EP-DM-CON-ICD-0034 Citizen Science Data

#### Image/Cutout Server

- DMS-REQ-0065 Provide Image Access Services
- DMS-REQ-0127 Access to input images for DAC-based Level 3 processing
- DMS-REQ-0155 Provide Data Access Services
- DMS-REQ-0293 Selection of Datasets

- DMS-REQ-0298 Data Product and Raw Data Access
- DMS-REQ-0311 Regenerate Un-archived Data Products
- DMS-REQ-0334 Persisting Data Products
- DMS-REQ-0336b Regenerating Data Products from Previous Data Releases
- DMS-REQ-0338 Targeted Coadds
- DMS-REQ-0339 Tracking Characterization Changes Between Data Releases
- DMS-REQ-0346 Data Availability
- DMS-REQ-0368 Implementation Provisions
- EP-DM-CON-ICD-0034 Citizen Science Data

#### Summit to Base Network

- DMS-REQ-0165 Infrastructure Sizing for "catching up"
- DMS-REQ-0166 Incorporate Fault-Tolerance
- DMS-REQ-0167 Incorporate Autonomics
- DMS-REQ-0168 Summit Facility Data Communications
- DMS-REQ-0171 Summit to Base Network
- DMS-REQ-0172 Summit to Base Network Availability
- DMS-REQ-0173 Summit to Base Network Reliability
- DMS-REQ-0174 Summit to Base Network Secondary Link
- DMS-REQ-0175 Summit to Base Network Ownership and Operation
- OCS-DM-COM-ICD-0053 Summit-Base Network Utilization

#### Base to Archive Network

- DMS-REQ-0165 Infrastructure Sizing for "catching up"
- DMS-REQ-0166 Incorporate Fault-Tolerance
- DMS-REQ-0167 Incorporate Autonomics
- DMS-REQ-0180 Base to Archive Network
- DMS-REQ-0181 Base to Archive Network Availability
- DMS-REQ-0182 Base to Archive Network Reliability
- DMS-REQ-0183 Base to Archive Network Secondary Link
- DMS-REQ-0188 Archive to Data Access Center Network
- DMS-REQ-0189 Archive to Data Access Center Network Availability
- DMS-REQ-0190 Archive to Data Access Center Network Reliability
- DMS-REQ-0191 Archive to Data Access Center Network Secondary Link
- OCS-DM-COM-ICD-0054 Base-Archive Network Utilization

#### Base LAN Network

- DMS-REQ-0165 Infrastructure Sizing for "catching up"
- DMS-REQ-0166 Incorporate Fault-Tolerance
- DMS-REQ-0167 Incorporate Autonomics

- DMS-REQ-0193 Data Access Centers
- DMS-REQ-0194 Data Access Center Simultaneous Connections
- DMS-REQ-0352 Base Wireless LAN (WiFi)

#### NCSA LAN Network

- DMS-REQ-0163 Re-processing Capacity
- DMS-REQ-0165 Infrastructure Sizing for "catching up"
- DMS-REQ-0166 Incorporate Fault-Tolerance
- DMS-REQ-0167 Incorporate Autonomics
- DMS-REQ-0188 Archive to Data Access Center Network
- DMS-REQ-0189 Archive to Data Access Center Network Availability
- DMS-REQ-0190 Archive to Data Access Center Network Reliability
- DMS-REQ-0191 Archive to Data Access Center Network Secondary Link
- DMS-REQ-0193 Data Access Centers
- DMS-REQ-0194 Data Access Center Simultaneous Connections

#### Network Management

- DMS-REQ-0008 Pipeline Availability
- DMS-REQ-0166 Incorporate Fault-Tolerance
- DMS-REQ-0167 Incorporate Autonomics
- DMS-REQ-0175 Summit to Base Network Ownership and Operation

#### Base Facility

- DM-TS-CON-ICD-0003 Wavefront image archive access
- DMS-REQ-0008 Pipeline Availability
- DMS-REQ-0161 Optimization of Cost, Reliability and Availability in Order
- DMS-REQ-0162 Pipeline Throughput
- DMS-REQ-0163 Re-processing Capacity
- DMS-REQ-0164 Temporary Storage for Communications Links
- DMS-REQ-0165 Infrastructure Sizing for "catching up"
- DMS-REQ-0166 Incorporate Fault-Tolerance
- DMS-REQ-0167 Incorporate Autonomics
- DMS-REQ-0170 Prefer Computing and Storage Down
- DMS-REQ-0176 Base Facility Infrastructure
- DMS-REQ-0178 Base Facility Co-Location with Existing Facility
- DMS-REQ-0193 Data Access Centers
- DMS-REQ-0196 Data Access Center Geographical Distribution
- DMS-REQ-0297 DMS Initialization Component
- DMS-REQ-0314 Compute Platform Heterogeneity
- DMS-REQ-0315 DMS Communication with OCS

- DMS-REQ-0316 Commissioning Cluster
- DMS-REQ-0318 Data Management Unscheduled Downtime
- DMS-REQ-0352 Base Wireless LAN (WiFi)
- OCS-DM-COM-ICD-0027 Multiple Physically Separated Copies

#### NCSA Facility

- DM-TS-CON-ICD-0003 Wavefront image archive access
- DMS-REQ-0008 Pipeline Availability
- DMS-REQ-0161 Optimization of Cost, Reliability and Availability in Order
- DMS-REQ-0162 Pipeline Throughput
- DMS-REQ-0163 Re-processing Capacity
- DMS-REQ-0164 Temporary Storage for Communications Links
- DMS-REQ-0165 Infrastructure Sizing for "catching up"
- DMS-REQ-0166 Incorporate Fault-Tolerance
- DMS-REQ-0167 Incorporate Autonomics
- DMS-REQ-0170 Prefer Computing and Storage Down
- DMS-REQ-0185 Archive Center
- DMS-REQ-0186 Archive Center Disaster Recovery
- DMS-REQ-0187 Archive Center Co-Location with Existing Facility
- DMS-REQ-0193 Data Access Centers
- DMS-REQ-0196 Data Access Center Geographical Distribution
- DMS-REQ-0297 DMS Initialization Component
- DMS-REQ-0314 Compute Platform Heterogeneity
- DMS-REQ-0318 Data Management Unscheduled Downtime
- OCS-DM-COM-ICD-0027 Multiple Physically Separated Copies

#### Archive Base Enclave

- CA-DM-CON-ICD-0019 Camera engineering image data archiving
- DM-TS-CON-ICD-0003 Wavefront image archive access
- DMS-REQ-0004 Nightly Data Accessible Within 24 hrs
- DMS-REQ-0010 Difference Exposures
- DMS-REQ-0029 Generate Photometric Zeropoint for Visit Image
- DMS-REQ-0030 Generate WCS for Visit Images
- DMS-REQ-0069 Processed Visit Images
- DMS-REQ-0077 Maintain Archive Publicly Accessible
- DMS-REQ-0078 Catalog Export Formats
- DMS-REQ-0089 Solar System Objects Available Within Specified Time
- DMS-REQ-0094 Keep Historical Alert Archive
- DMS-REQ-0102 Provide Engineering and Facility Database Archive
- DMS-REQ-0106 Coadded Image Provenance
- DMS-REQ-0131 Calibration Images Available Within Specified Time

- DMS-REQ-0161 Optimization of Cost, Reliability and Availability in Order
- DMS-REQ-0162 Pipeline Throughput
- DMS-REQ-0163 Re-processing Capacity
- DMS-REQ-0166 Incorporate Fault-Tolerance
- DMS-REQ-0167 Incorporate Autonomics
- DMS-REQ-0176 Base Facility Infrastructure
- DMS-REQ-0186 Archive Center Disaster Recovery
- DMS-REQ-0266 Exposure Catalog
- DMS-REQ-0267 Source Catalog
- DMS-REQ-0268 Forced-Source Catalog
- DMS-REQ-0269 DIASource Catalog
- DMS-REQ-0270 Faint DIASource Measurements
- DMS-REQ-0271 DIAObject Catalog
- DMS-REQ-0272 DIAObject Attributes
- DMS-REQ-0273 SSObject Catalog
- DMS-REQ-0274 Alert Content
- DMS-REQ-0275 Object Catalog
- DMS-REQ-0284 Level-1 Production Completeness
- DMS-REQ-0287 DIASource Precovery
- DMS-REQ-0291 Query Repeatability
- DMS-REQ-0309 Raw Data Archiving Reliability
- DMS-REQ-0310 Un-Archived Data Product Cache
- DMS-REQ-0312 Level 1 Data Product Access
- DMS-REQ-0314 Compute Platform Heterogeneity
- DMS-REQ-0317 DIAForcedSource Catalog
- DMS-REQ-0318 Data Management Unscheduled Downtime
- DMS-REQ-0322 Special Programs Database
- DMS-REQ-0324 Matching DIASources to Objects
- DMS-REQ-0327 Background Model Calculation
- DMS-REQ-0334 Persisting Data Products
- DMS-REQ-0338 Targeted Coadds
- DMS-REQ-0344 Constraints on Level 1 Special Program Products Generation
- DMS-REQ-0363 Access to Previous Data Releases
- DMS-REQ-0364 Data Access Services
- DMS-REQ-0365 Operations Subsets
- DMS-REQ-0366 Subsets Support
- DMS-REQ-0367 Access Services Performance
- DMS-REQ-0368 Implementation Provisions
- DMS-REQ-0369 Evolution
- DMS-REQ-0370 Older Release Behavior
- OCS-DM-COM-ICD-0027 Multiple Physically Separated Copies
- OCS-DM-COM-ICD-0028 Expected Data Volume
- OCS-DM-COM-ICD-0029 Archive Latency
- OCS-DM-COM-ICD-0030 EFD Transformation Service Interface

## Archive NCSA Enclave

- CA-DM-CON-ICD-0019 Camera engineering image data archiving
- DM-TS-CON-ICD-0003 Wavefront image archive access
- DMS-REQ-0004 Nightly Data Accessible Within 24 hrs
- DMS-REQ-0010 Difference Exposures
- DMS-REQ-0029 Generate Photometric Zeropoint for Visit Image
- DMS-REQ-0030 Generate WCS for Visit Images
- DMS-REQ-0069 Processed Visit Images
- DMS-REQ-0077 Maintain Archive Publicly Accessible
- DMS-REQ-0078 Catalog Export Formats
- DMS-REQ-0089 Solar System Objects Available Within Specified Time
- DMS-REQ-0094 Keep Historical Alert Archive
- DMS-REQ-0102 Provide Engineering and Facility Database Archive
- DMS-REQ-0106 Coadded Image Provenance
- DMS-REQ-0131 Calibration Images Available Within Specified Time
- DMS-REQ-0161 Optimization of Cost, Reliability and Availability in Order
- DMS-REQ-0162 Pipeline Throughput
- DMS-REQ-0163 Re-processing Capacity
- DMS-REQ-0166 Incorporate Fault-Tolerance
- DMS-REQ-0167 Incorporate Autonomics
- DMS-REQ-0185 Archive Center
- DMS-REQ-0186 Archive Center Disaster Recovery
- DMS-REQ-0266 Exposure Catalog
- DMS-REQ-0267 Source Catalog
- DMS-REQ-0268 Forced-Source Catalog
- DMS-REQ-0269 DIASource Catalog
- DMS-REQ-0270 Faint DIASource Measurements
- DMS-REQ-0271 DIAObject Catalog
- DMS-REQ-0272 DIAObject Attributes
- DMS-REQ-0273 SSObject Catalog
- DMS-REQ-0274 Alert Content
- DMS-REQ-0275 Object Catalog
- DMS-REQ-0284 Level-1 Production Completeness
- DMS-REQ-0287 DIASource Precovery
- DMS-REQ-0291 Query Repeatability
- DMS-REQ-0309 Raw Data Archiving Reliability
- DMS-REQ-0310 Un-Archived Data Product Cache
- DMS-REQ-0312 Level 1 Data Product Access
- DMS-REQ-0314 Compute Platform Heterogeneity
- DMS-REQ-0317 DIAForcedSource Catalog
- DMS-REQ-0318 Data Management Unscheduled Downtime
- DMS-REQ-0322 Special Programs Database
- DMS-REQ-0324 Matching DIASources to Objects

- DMS-REQ-0327 Background Model Calculation
- DMS-REQ-0334 Persisting Data Products
- DMS-REQ-0338 Targeted Coadds
- DMS-REQ-0344 Constraints on Level 1 Special Program Products Generation
- DMS-REQ-0363 Access to Previous Data Releases
- DMS-REQ-0364 Data Access Services
- DMS-REQ-0365 Operations Subsets
- DMS-REQ-0366 Subsets Support
- DMS-REQ-0367 Access Services Performance
- DMS-REQ-0368 Implementation Provisions
- DMS-REQ-0369 Evolution
- DMS-REQ-0370 Older Release Behavior
- OCS-DM-COM-ICD-0027 Multiple Physically Separated Copies
- OCS-DM-COM-ICD-0028 Expected Data Volume
- OCS-DM-COM-ICD-0029 Archive Latency
- OCS-DM-COM-ICD-0030 EFD Transformation Service Interface

#### Commissioning Cluster Enclave

- DMS-REQ-0161 Optimization of Cost, Reliability and Availability in Order
- DMS-REQ-0166 Incorporate Fault-Tolerance
- DMS-REQ-0167 Incorporate Autonomics
- DMS-REQ-0176 Base Facility Infrastructure
- DMS-REQ-0314 Compute Platform Heterogeneity
- DMS-REQ-0316 Commissioning Cluster
- DMS-REQ-0318 Data Management Unscheduled Downtime

#### DAC Chile Enclave

- DMS-REQ-0004 Nightly Data Accessible Within 24 hrs
- DMS-REQ-0075 Catalog Queries
- DMS-REQ-0077 Maintain Archive Publicly Accessible
- DMS-REQ-0078 Catalog Export Formats
- DMS-REQ-0089 Solar System Objects Available Within Specified Time
- DMS-REQ-0094 Keep Historical Alert Archive
- DMS-REQ-0102 Provide Engineering and Facility Database Archive
- DMS-REQ-0119 DAC resource allocation for Level 3 processing
- DMS-REQ-0120 Level 3 Data Product Self Consistency
- DMS-REQ-0121 Provenance for Level 3 processing at DACs
- DMS-REQ-0123 Access to input catalogs for DAC-based Level 3 processing
- DMS-REQ-0127 Access to input images for DAC-based Level 3 processing
- DMS-REQ-0131 Calibration Images Available Within Specified Time
- DMS-REQ-0161 Optimization of Cost, Reliability and Availability in Order

- DMS-REQ-0162 Pipeline Throughput
- DMS-REQ-0166 Incorporate Fault-Tolerance
- DMS-REQ-0167 Incorporate Autonomics
- DMS-REQ-0176 Base Facility Infrastructure
- DMS-REQ-0193 Data Access Centers
- DMS-REQ-0194 Data Access Center Simultaneous Connections
- DMS-REQ-0196 Data Access Center Geographical Distribution
- DMS-REQ-0284 Level-1 Production Completeness
- DMS-REQ-0287 DIASource Precovery
- DMS-REQ-0291 Query Repeatability
- DMS-REQ-0309 Raw Data Archiving Reliability
- DMS-REQ-0310 Un-Archived Data Product Cache
- DMS-REQ-0311 Regenerate Un-archived Data Products
- DMS-REQ-0312 Level 1 Data Product Access
- DMS-REQ-0313 Level 1 and 2 Catalog Access
- DMS-REQ-0314 Compute Platform Heterogeneity
- DMS-REQ-0318 Data Management Unscheduled Downtime
- DMS-REQ-0322 Special Programs Database
- DMS-REQ-0323 Calculating SSOBJECT Parameters
- DMS-REQ-0324 Matching DIASources to Objects
- DMS-REQ-0334 Persisting Data Products
- DMS-REQ-0336b Regenerating Data Products from Previous Data Releases
- DMS-REQ-0338 Targeted Coadds
- DMS-REQ-0339 Tracking Characterization Changes Between Data Releases
- DMS-REQ-0340 Access Controls of Level 3 Data Products
- DMS-REQ-0341 Providing a Precovery Service
- DMS-REQ-0344 Constraints on Level 1 Special Program Products Generation
- DMS-REQ-0345 Logging of catalog queries
- DMS-REQ-0363 Access to Previous Data Releases
- DMS-REQ-0364 Data Access Services
- DMS-REQ-0365 Operations Subsets
- DMS-REQ-0366 Subsets Support
- DMS-REQ-0367 Access Services Performance
- DMS-REQ-0368 Implementation Provisions
- DMS-REQ-0369 Evolution
- DMS-REQ-0370 Older Release Behavior
- OCS-DM-COM-ICD-0029 Archive Latency

#### DAC US Enclave

- DMS-REQ-0004 Nightly Data Accessible Within 24 hrs
- DMS-REQ-0075 Catalog Queries
- DMS-REQ-0077 Maintain Archive Publicly Accessible
- DMS-REQ-0078 Catalog Export Formats

- DMS-REQ-0089 Solar System Objects Available Within Specified Time
- DMS-REQ-0094 Keep Historical Alert Archive
- DMS-REQ-0102 Provide Engineering and Facility Database Archive
- DMS-REQ-0119 DAC resource allocation for Level 3 processing
- DMS-REQ-0120 Level 3 Data Product Self Consistency
- DMS-REQ-0121 Provenance for Level 3 processing at DACs
- DMS-REQ-0123 Access to input catalogs for DAC-based Level 3 processing
- DMS-REQ-0127 Access to input images for DAC-based Level 3 processing
- DMS-REQ-0131 Calibration Images Available Within Specified Time
- DMS-REQ-0161 Optimization of Cost, Reliability and Availability in Order
- DMS-REQ-0162 Pipeline Throughput
- DMS-REQ-0166 Incorporate Fault-Tolerance
- DMS-REQ-0167 Incorporate Autonomics
- DMS-REQ-0185 Archive Center
- DMS-REQ-0186 Archive Center Disaster Recovery
- DMS-REQ-0193 Data Access Centers
- DMS-REQ-0194 Data Access Center Simultaneous Connections
- DMS-REQ-0196 Data Access Center Geographical Distribution
- DMS-REQ-0284 Level-1 Production Completeness
- DMS-REQ-0287 DIASource Precovery
- DMS-REQ-0291 Query Repeatability
- DMS-REQ-0309 Raw Data Archiving Reliability
- DMS-REQ-0310 Un-Archived Data Product Cache
- DMS-REQ-0311 Regenerate Un-archived Data Products
- DMS-REQ-0312 Level 1 Data Product Access
- DMS-REQ-0313 Level 1 and 2 Catalog Access
- DMS-REQ-0314 Compute Platform Heterogeneity
- DMS-REQ-0318 Data Management Unscheduled Downtime
- DMS-REQ-0322 Special Programs Database
- DMS-REQ-0323 Calculating SSOBJect Parameters
- DMS-REQ-0324 Matching DIASources to Objects
- DMS-REQ-0334 Persisting Data Products
- DMS-REQ-0336b Regenerating Data Products from Previous Data Releases
- DMS-REQ-0338 Targeted Coadds
- DMS-REQ-0339 Tracking Characterization Changes Between Data Releases
- DMS-REQ-0340 Access Controls of Level 3 Data Products
- DMS-REQ-0341 Providing a Precovery Service
- DMS-REQ-0344 Constraints on Level 1 Special Program Products Generation
- DMS-REQ-0345 Logging of catalog queries
- DMS-REQ-0363 Access to Previous Data Releases
- DMS-REQ-0364 Data Access Services
- DMS-REQ-0365 Operations Subsets
- DMS-REQ-0366 Subsets Support
- DMS-REQ-0367 Access Services Performance

- DMS-REQ-0368 Implementation Provisions
- DMS-REQ-0369 Evolution
- DMS-REQ-0370 Older Release Behavior
- EP-DM-CON-ICD-0002 EPO is an Authorized Science User
- EP-DM-CON-ICD-0034 Citizen Science Data
- OCS-DM-COM-ICD-0029 Archive Latency

#### Offline Production Enclave

- DM-TS-CON-ICD-0003 Wavefront image archive access
- DMS-REQ-0004 Nightly Data Accessible Within 24 hrs
- DMS-REQ-0008 Pipeline Availability
- DMS-REQ-0034 Associate Sources to Objects
- DMS-REQ-0046 Provide Photometric Redshifts of Galaxies
- DMS-REQ-0047 Provide PSF for Coadded Images
- DMS-REQ-0059 Bad Pixel Map
- DMS-REQ-0060 Bias Residual Image
- DMS-REQ-0061 Crosstalk Correction Matrix
- DMS-REQ-0062 Illumination Correction Frame
- DMS-REQ-0063 Monochromatic Flatfield Data Cube
- DMS-REQ-0103 Produce Images for EPO
- DMS-REQ-0106 Coadded Image Provenance
- DMS-REQ-0130 Calibration Data Products
- DMS-REQ-0131 Calibration Images Available Within Specified Time
- DMS-REQ-0132 Calibration Image Provenance
- DMS-REQ-0161 Optimization of Cost, Reliability and Availability in Order
- DMS-REQ-0162 Pipeline Throughput
- DMS-REQ-0163 Re-processing Capacity
- DMS-REQ-0166 Incorporate Fault-Tolerance
- DMS-REQ-0167 Incorporate Autonomics
- DMS-REQ-0185 Archive Center
- DMS-REQ-0186 Archive Center Disaster Recovery
- DMS-REQ-0267 Source Catalog
- DMS-REQ-0268 Forced-Source Catalog
- DMS-REQ-0275 Object Catalog
- DMS-REQ-0277 Coadd Source Catalog
- DMS-REQ-0278 Coadd Image Method Constraints
- DMS-REQ-0279 Deep Detection Coadds
- DMS-REQ-0280 Template Coadds
- DMS-REQ-0281 Multi-band Coadds
- DMS-REQ-0282 Dark Current Correction Frame
- DMS-REQ-0283 Fringe Correction Frame
- DMS-REQ-0284 Level-1 Production Completeness
- DMS-REQ-0286 SSObject Precovery

- DMS-REQ-0287 DIASource Precovery
- DMS-REQ-0289 Calibration Production Processing
- DMS-REQ-0314 Compute Platform Heterogeneity
- DMS-REQ-0318 Data Management Unscheduled Downtime
- DMS-REQ-0320 Processing of Data From Special Programs
- DMS-REQ-0325 Regenerating L1 Data Products During Data Release Processing
- DMS-REQ-0329 All-Sky Visualization of Data Releases
- DMS-REQ-0330 Best Seeing Coadds
- DMS-REQ-0334 Persisting Data Products
- DMS-REQ-0335 PSF-Matched Coadds
- DMS-REQ-0341 Providing a Precovery Service
- EP-DM-CON-ICD-0037 EPO Compute Cluster

#### Prompt Base Enclave

- CA-DM-CON-ICD-0007 Provide Data Management Conditions data
- CA-DM-CON-ICD-0008 Data Management Conditions data latency
- CA-DM-CON-ICD-0014 Provide science sensor data
- CA-DM-CON-ICD-0015 Provide wavefront sensor data
- CA-DM-CON-ICD-0016 Provide guide sensor data
- CA-DM-CON-ICD-0017 Data Management load on image data interfaces
- CA-DM-CON-ICD-0019 Camera engineering image data archiving
- DM-TS-CON-ICD-0002 Timing
- DM-TS-CON-ICD-0003 Wavefront image archive access
- DM-TS-CON-ICD-0004 Use OCS for data transport
- DM-TS-CON-ICD-0006 Data
- DM-TS-CON-ICD-0007 Timing
- DM-TS-CON-ICD-0009 Calibration Data Products
- DM-TS-CON-ICD-0011 Data Format
- DMS-REQ-0004 Nightly Data Accessible Within 24 hrs
- DMS-REQ-0008 Pipeline Availability
- DMS-REQ-0018 Raw Science Image Data Acquisition
- DMS-REQ-0020 Wavefront Sensor Data Acquisition
- DMS-REQ-0022 Crosstalk Corrected Science Image Data Acquisition
- DMS-REQ-0024 Raw Image Assembly
- DMS-REQ-0068 Raw Science Image Metadata
- DMS-REQ-0096 Generate Data Quality Report Within Specified Time
- DMS-REQ-0097 Level 1 Data Quality Report Definition
- DMS-REQ-0098 Generate DMS Performance Report Within Specified Time
- DMS-REQ-0099 Level 1 Performance Report Definition
- DMS-REQ-0100 Generate Calibration Report Within Specified Time
- DMS-REQ-0101 Level 1 Calibration Report Definition
- DMS-REQ-0102 Provide Engineering and Facility Database Archive
- DMS-REQ-0161 Optimization of Cost, Reliability and Availability in Order

- DMS-REQ-0162 Pipeline Throughput
- DMS-REQ-0164 Temporary Storage for Communications Links
- DMS-REQ-0165 Infrastructure Sizing for "catching up"
- DMS-REQ-0166 Incorporate Fault-Tolerance
- DMS-REQ-0167 Incorporate Autonomics
- DMS-REQ-0176 Base Facility Infrastructure
- DMS-REQ-0265 Guider Calibration Data Acquisition
- DMS-REQ-0284 Level-1 Production Completeness
- DMS-REQ-0309 Raw Data Archiving Reliability
- DMS-REQ-0314 Compute Platform Heterogeneity
- DMS-REQ-0315 DMS Communication with OCS
- DMS-REQ-0318 Data Management Unscheduled Downtime
- DMS-REQ-0353 Publishing predicted visit schedule
- OCS-DM-COM-ICD-0003 Data Management CSC Command Response Model
- OCS-DM-COM-ICD-0004 Data Management Exposed CSCs
- OCS-DM-COM-ICD-0005 Main Camera Archiver
- OCS-DM-COM-ICD-0006 Catch-up Archiver
- OCS-DM-COM-ICD-0007 Prompt Processing CSC
- OCS-DM-COM-ICD-0008 EFD Transformation Service CSC
- OCS-DM-COM-ICD-0009 Command Set Implementation by Data Management
- OCS-DM-COM-ICD-0017 Data Management Telemetry Interface Model
- OCS-DM-COM-ICD-0018 Data Management Telemetry Time Stamp
- OCS-DM-COM-ICD-0019 Data Management Events and Telemetry Required by the OCS
- OCS-DM-COM-ICD-0020 Image and Visit Processing and Archiving Status
- OCS-DM-COM-ICD-0021 Data Quality Metrics
- OCS-DM-COM-ICD-0022 System Health Metrics
- OCS-DM-COM-ICD-0025 Expected Load of Queries from DM
- OCS-DM-COM-ICD-0026 Engineering and Facilities Database Archiving by Data Management
- OCS-DM-COM-ICD-0027 Multiple Physically Separated Copies
- OCS-DM-COM-ICD-0028 Expected Data Volume
- OCS-DM-COM-ICD-0030 EFD Transformation Service Interface

#### Prompt NCSA Enclave

- CA-DM-CON-ICD-0019 Camera engineering image data archiving
- DMS-REQ-0002 Transient Alert Distribution
- DMS-REQ-0004 Nightly Data Accessible Within 24 hrs
- DMS-REQ-0008 Pipeline Availability
- DMS-REQ-0010 Difference Exposures
- DMS-REQ-0029 Generate Photometric Zeropoint for Visit Image
- DMS-REQ-0030 Generate WCS for Visit Images
- DMS-REQ-0069 Processed Visit Images
- DMS-REQ-0070 Generate PSF for Visit Images
- DMS-REQ-0072 Processed Visit Image Content

- DMS-REQ-0074 Difference Exposure Attributes
- DMS-REQ-0096 Generate Data Quality Report Within Specified Time
- DMS-REQ-0097 Level 1 Data Quality Report Definition
- DMS-REQ-0098 Generate DMS Performance Report Within Specified Time
- DMS-REQ-0099 Level 1 Performance Report Definition
- DMS-REQ-0100 Generate Calibration Report Within Specified Time
- DMS-REQ-0101 Level 1 Calibration Report Definition
- DMS-REQ-0102 Provide Engineering and Facility Database Archive
- DMS-REQ-0131 Calibration Images Available Within Specified Time
- DMS-REQ-0161 Optimization of Cost, Reliability and Availability in Order
- DMS-REQ-0162 Pipeline Throughput
- DMS-REQ-0165 Infrastructure Sizing for "catching up"
- DMS-REQ-0166 Incorporate Fault-Tolerance
- DMS-REQ-0167 Incorporate Autonomics
- DMS-REQ-0185 Archive Center
- DMS-REQ-0266 Exposure Catalog
- DMS-REQ-0269 DIASource Catalog
- DMS-REQ-0270 Faint DIASource Measurements
- DMS-REQ-0271 DIAObject Catalog
- DMS-REQ-0272 DIAObject Attributes
- DMS-REQ-0273 SSObject Catalog
- DMS-REQ-0274 Alert Content
- DMS-REQ-0284 Level-1 Production Completeness
- DMS-REQ-0309 Raw Data Archiving Reliability
- DMS-REQ-0314 Compute Platform Heterogeneity
- DMS-REQ-0317 DIAForcedSource Catalog
- DMS-REQ-0318 Data Management Unscheduled Downtime
- DMS-REQ-0319 Characterizing Variability
- DMS-REQ-0320 Processing of Data From Special Programs
- DMS-REQ-0321 Level 1 Processing of Special Programs Data
- DMS-REQ-0327 Background Model Calculation
- DMS-REQ-0328 Documenting Image Characterization
- DMS-REQ-0343 Performance Requirements for LSST Alert Filtering Service
- DMS-REQ-0344 Constraints on Level 1 Special Program Products Generation

## 16 References

- [1] **[LDM-141]**, Becla, J., Lim, K.T., 2013, *Data Management Storage Sizing and I/O Model*, Data Management Controlled Document LDM-141, NSF-DOE Vera C. Rubin Observatory, URL <https://ls.st/LDM-141>

- [2] **[LSE-29]**, Claver, C.F., The LSST Systems Engineering Integrated Project Team, 2017, *LSST System Requirements (LSR)*, Systems Engineering Controlled Document LSE-29, NSF-DOE Vera C. Rubin Observatory, URL <https://ls.st/LSE-29>
- [3] **[LSE-30]**, Claver, C.F., The LSST Systems Engineering Integrated Project Team, 2018, *Observatory System Specifications (OSS)*, Systems Engineering Controlled Document LSE-30, NSF-DOE Vera C. Rubin Observatory, URL <https://ls.st/LSE-30>
- [4] **[LSE-81]**, Dubois-Felsmann, G., 2013, *LSST Science and Project Sizing Inputs*, Systems Engineering Controlled Document LSE-81, NSF-DOE Vera C. Rubin Observatory, URL <https://ls.st/LSE-81>
- [5] **[LSE-61]**, Dubois-Felsmann, G., Jenness, T., 2019, *Data Management System (DMS) Requirements*, Systems Engineering Controlled Document LSE-61, NSF-DOE Vera C. Rubin Observatory, URL <https://lse-61.lsst.io/>, doi:10.71929/rubin/2587200
- [6] **[LSE-82]**, Dubois-Felsmann, G., Lim, K.T., 2013, *Science and Project Sizing Inputs Explanation*, Systems Engineering Controlled Document LSE-82, NSF-DOE Vera C. Rubin Observatory, URL <https://ls.st/LSE-82>
- [7] **[LSE-72]**, Dubois-Felsmann, G., Schumacher, G., Selvy, B., 2014, *OCS Command Dictionary for Data Management*, Systems Engineering Controlled Document LSE-72, NSF-DOE Vera C. Rubin Observatory, URL <https://ls.st/LSE-72>
- [8] **[LDM-542]**, Dubois-Felsmann, G., Economou, F., Lim, K.T., et al., 2019, *Science Platform Design*, Data Management Controlled Document LDM-542, NSF-DOE Vera C. Rubin Observatory, URL <https://ldm-542.lsst.io/>
- [9] **[LSE-163]**, Jurić, M., Axelrod, T., Becker, A., et al., 2023, *Data Products Definition Document*, Systems Engineering Controlled Document LSE-163, NSF-DOE Vera C. Rubin Observatory, URL <https://lse-163.lsst.io/>, doi:10.71929/rubin/2587118
- [10] **[LSE-78]**, Lambert, R., Kantor, J., Huffer, M., et al., 2017, *LSST Observatory Network Design*, Systems Engineering Controlled Document LSE-78, NSF-DOE Vera C. Rubin Observatory, URL <https://ls.st/LSE-78>
- [11] **[LDM-152]**, Lim, K.T., Dubois-Felsmann, G., Johnson, M., Juric, M., Petravick, D., 2019, *Data Management Middleware Design*, Data Management Controlled Document LDM-152, NSF-DOE Vera C. Rubin Observatory, URL <https://ldm-152.lsst.io/>
- [12] LSST Data Management, LSST DM Developer Guide, URL <https://developer.lsst.io/>
- [13] **[DMTN-135]**, O'Mullane, W., Dubois, R., Butler, M., Lim, K.T., 2023, *DM sizing model and cost plan for construction and operations.*, Data Management Technical Note DMTN-135, NSF-DOE Vera C. Rubin Observatory, URL <https://dmtn-135.lsst.io/>
- [14] **[LDM-230]**, Petravick, D., Butler, M., Gelman, M., 2018, *Concept of Operations for the LSST Data Facility Services*, Data Management Controlled Document LDM-230, NSF-DOE Vera C. Rubin Observatory, URL <https://ldm-230.lsst.io/>
- [15] **[LDM-129]**, Petravick, D., Johnson, M., Butler, M., 2018, *LSST Data Facility Logical Information Technology and Communications Design*, Data Management Controlled Document LDM-129, NSF-DOE Vera C. Rubin Observatory, URL <https://ls.st/LDM-129>

- [16] **[LPM-121]**, Petravick, D.L., Withers, A., 2016, *LSST Master Information Security Policy*, Project Controlled Document LPM-121, NSF-DOE Vera C. Rubin Observatory, URL <https://ls.st/LPM-121>
- [17] **[LDM-151]**, Swinbank, J., Axelrod, T., Becker, A., et al., 2020, *Data Management Science Pipelines Design*, Data Management Controlled Document LDM-151, NSF-DOE Vera C. Rubin Observatory, URL <https://ldm-151.lsst.io/>, doi:10.71929/rubin/2587108