



LARGE SYNOPTIC SURVEY TELESCOPE

Data Management Organization

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Abstract

This is the DM plan updaed from the v2 of 2014. It covers the organisation and managemnt of DM for LSST.

Document History

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2	1	2017-01-09	WOM, MJ	Update in TeX
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1 Introduction

1.1 Purpose

This document defines the mission, goals and objectives, organization and responsibilities of the LSST Data Management Organization (DMO). The document is currently scoped to define these elements for the LSST Design and Development, Construction, and Commissioning phases. It does not presently address any ongoing mission for the DMO during LSST operations.

1.2 Mission

To be discussed in Tucson - fundamentally do we not have to produce alerts/catalogues and images ? Not technology ... The mission of Data Management Organization (DMO) is to provide technology and operational capabilities for the acquisition, quality assessment, processing, end user and external system access, provenance, and archiving of open, publicly accessible, scientific data and associated engineering and quality data generated by the LSST as a result of scientific projects and telescope operations.

1.3 Goals And Objectives

The Data Management Organization will:

- Define the data products, data access mechanisms, and data management and curation requirements for the LSST
- Assess current and LSST-timeframe technologies for use in providing engineered solutions to the requirements
- Define the computing, communications, and storage infrastructure and services architecture underlying LSST data management
- Select, implement, construct, test, document, and deploy the LSST data management infrastructure, middleware, applications, and external interfaces
- Document the operational procedures associated with using and maintaining the LSST data management capabilities
- Evaluate, select, recruit, hire/contract and direct permanent staff, contract, and in-kind resources in LSST and from partner organizations participating in LSST Data Management initiatives.

2 Data Management Organization Structure

This section defines the organization structure for the period in which the DM System is developed and commissioned, up to the start of LSST Observatory operations. (Appendix B gives historical Pre-Construction Phase Organization).

The DM Project Manager and DM Project Scientist, who are known collectively as DM Management, lead the DM Subsystem. The Project Manager has direct responsibility for coordination with the overall LSST Project Office, the LSST Change Control Board, the LSST Corporation, and LSST partner organizations on all budgetary, schedule, and resource matters. The Project Scientist has primary scientific and technical responsibility in the DM and responsibility for ensuring that the scientific requirements of the LSST are supported, and is a member on the LSST Project Science Team (PST).

As shown in Figure 1, the organization now features lead institutions, each with responsibility for major element of the DM System (Level 2 Work Breakdown Structure elements). For example, during Final Design, the Process Control and Archive Site Manager and Team at NCSA will be conducting prototyping activities in computing, data communications, and data storage to select and verify the ability of System technologies to support the LSST requirements. They will also be involved in creating a supporting infrastructure for the DM Systems. During Construction before the LSST first light time frame, these resources will be focused on implementation of the selected technologies. In order to ensure that team functions as one integrated project, the institutions coordinate support by other lead institution team members directly through this organizational structure, as well as via a number of cross-organizational bodies (described later in this document). Also, due to the span of the organization, the DM Project Manager may be supported by one of the lead institution Project Managers as a Deputy Project Manager in these phases.

3 Roles in Data Management

There are many roles listed in Figure 1, this section enumerates responsibilities going with those roles.

3.1 DM Project Manager

The DM Project Manager is responsible for the efficient coordination of all LSST activities and responsibilities assigned to the Data Management Subsystem. The DM Project Manager has the responsibility of establishing the organization, resources, and work assignments to provide DM solutions. The DM Project Manager, serves as the DM representative in the LSST Project Office and in that role is responsible for presenting DM initiative status and submitting new

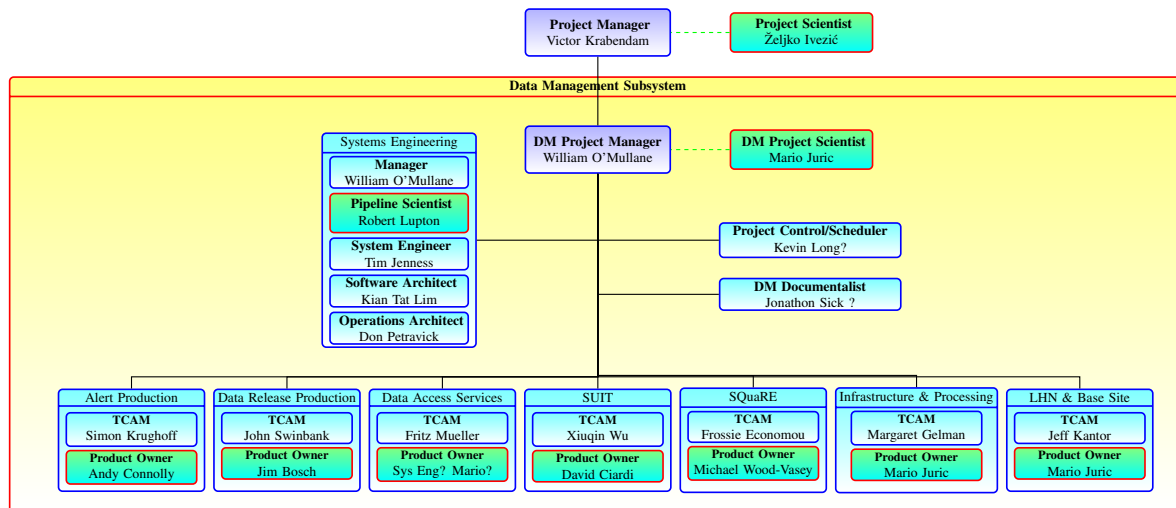


FIGURE 1: DM organisation with Scientists in Green.

DM initiatives for approval consideration. Ultimately, the DM Project Manager, in conjunction with his / her peer Project Managers (Telescope, Camera), is responsible for delivering an integrated LSST system. The DM Project Manager reports to the LSST Project Manager. Specific responsibilities include:

- Manage the overall DM System
- Define scope and funding for DM System
- Develop and implement the DM project management and control process, including earned value management
- Approve the DM Work Breakdown Structure (WBS), budgets and resource estimates
- Approve or execute as appropriate all DM outsourcing contracts
- Convene and/or participate in all DM reviews
- Co-Chair the DM Leadership Team

3.2 DM Project Scientist

The DM Project Scientist has ultimate responsibility for ensuring DM initiatives provide solutions that meet the overall LSST scientific and technical requirements. The DM Project Sci-

entist must ensure correct specification of DM Scientific Requirements and proper translation of those requirements into derived information technology requirements and ultimately, into implemented solutions. The DM Project Scientist must ensure that the DM subsystem is properly scoped and integrated within the overall LSST system. The DM Project Scientist is also a member of the LSST Project Science Team (PST) and reports to the LSST Director. Specific responsibilities include:

- Responsible for the science deliverables of the DM System
- Set requirements for the DM that:
 - Ensure that the design and operational flow of the data products meet the needs of the science community
 - Ensure that the quality requirements of the data products will be / are being met by the DMS, with a particular emphasis on choice of appropriate application algorithms
- Set requirements for and assess/validate results of Data Challenges and other precursor experiments
- Set requirements and assess/validate results for Data Releases
- Convene and/or participate in all DM reviews
- Co-Chair the DM Leadership Team and Science/Architecture Team

3.3 Project Controller/Scheduler

Keep AGILE plan in sync with the overall LSST planning (primavera), track milestones from TCAMS Section 3.4. Help TCAMS with building the plan from the milestones tracking dependencies and keeping it up to date.

Help set up sprint - points available (start/end day, account for holidays etc.) Bug team in general about story status in sprints and their tracking status (points spent).

Create reports and gannt charts for the DM Project Manager as needed Section 3.1

3.4 Technical Control/Account Manager (TCAM)

Accountable for planning and execution in their area. Reporting to the DM Project Manager Section 3.1. In AGILE could also be seen as the SCRUM Master for the local team.

3.5 Product Owner

The product owner, aka. the X scientist (where X is the product e.g. Alerts Production), is responsible for the product quality and acceptance. The product owner should sign off on the requirements to be fulfilled in every delivery and therefore also on any descopes or enhancements. The Product owner should define tests which can be run to prove a delivery meets the requirements due for that product.

3.6 Pipeline Scientist

Several DM products come together to form the LSST pipeline. The Pipeline Scientist is the product owner for the overall pipeline. The Pipeline Scientist should :

- Provide guidance and test criteria for the full pipeline including how QA is done on the products.
- Keep the big picture of where the codes are going in view. Predominantly the algorithms, but also the implementation and architecture (as part of the System Engineering Team Section 4.2).
- Advise on how we should attack algorithmic problems, providing continuing advice to subsystem product owners as we try new things.
- Advise on calibration issues, provide understanding of the detectors from a DM point of view.
- Advise on the overall (scientific) performance of the system, and how we'll test it. Thinking about all the small things that we have to get right to make the overall system good.

3.7 System Engineer

With the system engineering team Section 4.2 the System engineer owns the DM entries in the risk register and is generally in charge of the *process* of building DM products.

The System engineer is responsible for the requirements work:

- E.g., updating the DMSR, OSS, LSR (including traceability)
- Ensure we're appropriately modelling and recording information about the system (e.g., drawings, design documents, etc.)

- Overseeing work on ICDs, lower level requirements documents, etc.
- Ensuring we have a solid verification plans/standards across the board in DM

The System Engineer is responsible for the process to define & maintain DM interfaces

- Defining standards for and ensuring internal interfaces are identified and worked out
- Direct Interface Scientist's work on external ICDs

The System Engineer shall Chair the DM Technical Control Team Section 4.4

- Organise TCT processes so our change control process runs smoothly
- Shepherd RFCs through change control
- Monitor + Flag RFCs requiring TCT attention
- Call up meetings, make sure decisions are made, and recorded

The System Engineer represents DM on the CCB

- Shepherd DM's CRs through the CCB
- Serve as the Point of Contact for DM on the CCB

3.8 Software Architect

to be written The software architect looks after the software we are building. How does it all fit together are their techniques/technologies we should be using. How can we minimise dependencies.

With the Section ?? the Software architect should also agree how to track requirements to code and verify requirements are i.e. are hooks required in the code ?

3.9 Operations Architect

The DM System Architect is responsible for ensuring that all elements of the DM systems, including operations teams, infrastructure, middle ware, applications, and interfaces, i come together to form an operable system. Specific responsibilities include:

- Setting up and coordinating Operations Rehearsals
- Ensuring Readiness of procedures and personnel for Operations
- Set standards for operations e..g procedure handling and operator logging
- Participate in stakeholder and end user coordination and approval processes and reviews
- Member of the LSST System Engineering Team

4 Data Management Groups/Bodies

Since the DM team is distributed in terms of geography and responsibility across the LSST partner and lead institutions, mechanisms are needed to ensure that the project remains on track at all times. There are three primary coordinating bodies to ensure the management, technical, and quality integrity of the DM project. All DM institutions have membership on these bodies, and all meet at least once per month during construction and commissioning.

4.1 DM Science Performance/Validation Team?

Run by DM PS .. tell us if we meet the science goals - investigate problems, analyse commissioning data.

4.2 DM System Engineering Team

Look after requirements traceability, interfaces, ..

4.3 DM Leadership Team

The DM Leadership Team (DMLT) purpose is to establish scope of work and resource allocation across DM and ensure overall project management integrity across DM. The following mandate established the DMLT:

- Charter/purpose
 - Maintain scope of work and keep within resource allocation across DM
 - Ensure overall project management integrity across DM
 - Ensure Earned Value management requirements are met
- Membership
 - Co-Chaired by the DM Project Manager and DM Project Scientist
 - Core members are Lead Institution Technical/Control Account Managers (T/CAMs or CAMs)
- Responsibilities
 - Prepares all budgets, schedules, plans
 - Meets every week to track progress, address issues/risks, adjust work assignments and schedules, and disseminate/discuss general PM communications
 - Creates and publishes monthly, quarterly, annual progress reports
 - Meets at start of each software development phase with SAT to establish detailed scope/work plan
 - Meets with SAT for change control (TCT)

The DM Leadership Team and the System Engineering Group (Section 4.2) work in synchrony. The DMLT makes sure the requirements and architecture/design are estimated and scheduled in accordance with LSST Project required budgets and schedules.

4.4 Technical Control Team

The DM Technical Control Team has responsibility for issues similar to those of the LSST Configuration Control Board, but restricted to those contained within the DM subsystem. The TCT reviews and approves changes to all baselines in the LSST Data Management System, including proposed changes to the DM System Requirements' (DMSR), reference design, sizing model, i.e. any LDM-xxx baseline document. The TCT makes sure these changes don't get into the baseline without proper change control. Note that the TCT does not author the Technical Baseline and has no specific technical deliverable charter, but it does validate that the form and content of the Technical Baseline is consistent with LSST project standards such as the System Engineering Management Plan (SEMP). Specific responsibilities for development of the Technical Baseline and evaluation of the content versus LSST and DM requirements are elsewhere in this document.

- Charter/purpose

- Ensure that the DM Technical Baseline (LDM-xxx) documents are baselined and once baselined only changed when necessary, according to LSST and DM configuration control processes
- Membership
 - Chaired by the System Engineer
 - Members include the DM System Architect, DM System Interfaces Scientist, DM SQuaRE Technical Manager and DM Project Manager
 - For on-line virtual meetings, if a quorum is not reached within one week, the DM Project Manager will make a unilateral decision
- Responsibilities
 - Determines when specification and deliverables are of sufficient maturity and quality to be baselined (placed under configuration controlled status) or released. The TCT reviews and approves proposed changes to baselined items.
 - Reviews and approves/rejects proposed changes to baselined items

5 Data Management Problem Management/Escalation

The above organizational structure allocates significant responsibility to lead institutions. As such, when problems arise that cannot be solved with the responsibility and scope allocated to an institution, the path of escalation and resolution of such problems must be clear. In cases of problems that cannot be solved within the DM organization, that escalation path must also be clear. Figure 2 depicts the escalation path for such problem resolution.

6 Data Management Senior Positions and Responsibilities

LSST Data Management Managers and Staff These individuals form the top level management of the DMO. DM Deputy Project Manager The DM Deputy Project Manager, if this position is implemented, assists the DM Project Manager in the efficient coordination of all LSST activities and responsibilities assigned to the DMO. Specific responsibilities are the same as the DM Project Manager, when delegated to the DM Deputy Project Manager by the DM Project Manager. DM Project Scientist The DM Project Scientist has ultimate responsibility for ensuring DMO initiatives provide solutions that meet the overall LSST scientific and technical requirements. The DM Project Scientist must ensure correct specification of DM Scientific Requirements and proper translation of those requirements into derived information technology requirements and ultimately, into implemented solutions. The DM Project Scientist must ensure that the DM subsystem is properly scoped and integrated within the overall LSST system. The

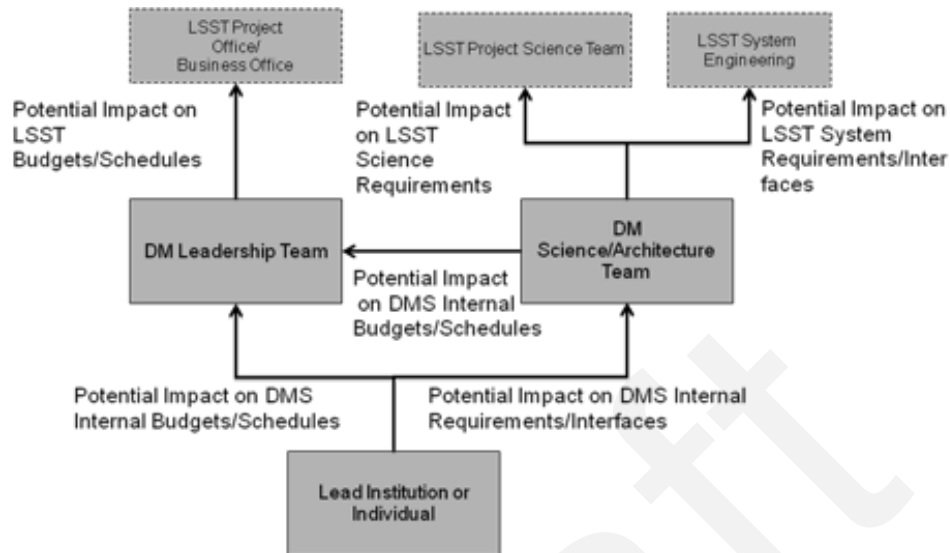


FIGURE 2: Problem Management/Escalation

DM Project Scientist is also a member of the LSST Project Science Team (PST) and reports to the LSST Director. Specific responsibilities include:

- Responsible for the science deliverables of the DM System
- Set requirements for the DMS that:

o Ensure that the design and operational flow of the data products meet the needs of the science community
o Ensure that the quality requirements of the data products will be / are being met by the DMS, with a particular emphasis on choice of appropriate application algorithms

- Set requirements for and assess/validate results of Data Challenges and other precursor experiments
- Set requirements and assess/validate results for Data Releases
- Convene and/or participate in all DM reviews
- Co-Chair the DM Leadership Team and Science/Architecture Team

6.1 DM Science Quality and Reliability Engineering (SQuaRE) Leads

The DM SQuaRE Leads are the SQuaRE Lead Scientist and the SQuaRE Technical Manager. The primary organizational responsibility for this Tucson-led group is to provide scientific and

technical feedback to the LSST DM Manager that demonstrates LSST/AURA DM is fulfilling its responsibilities as charged by the NSF with regards to science quality and software/IT performance and reliability. They are responsible for monitoring the reliability and maintainability of software developed by DM and the quality of the data products produced by the DM software in production. SQaRE's activities span processes and environments for software development, integration test and distribution. SQaRE also assumes responsibility for delivering any work in this area, though in many cases this may involve effort across the DM team. As such, areas of activity include:

- Development of algorithms to detect and analyze quality issues with data
- Infrastructure development to support the generation, collection, and analysis of data quality and performance metrics
- DM developer support services to ensure DM is using appropriate tools to aid software quality
- Support of publicly released software products, including porting and distributing it according to the scientific community's needs.

In the event that SQaRE identifies issues with the performance or future maintainability of the DM codebase, it brings them to the attention of the DM System Architect, who is ultimately responsible to decide who will address them and how. In the event that SQaRE identifies issues with the quality of the data, it brings them to the attention of the DM Project Scientist.

7 Lead Institution Senior Positions

Each Lead Institution has a Project Manager and Scientific/Engineering Lead, who jointly have overall end product responsibility for a broad area of DM work, typically a Work Breakdown Structure (WBS) Level 2 element. They are supervisors of the team at that institution. Their roles and responsibilities are similar to the DM Project Manager, DM Project Scientist, and DM System Architect, and DM QA and Test Lead, but within the scope of work assigned to that institution. These leaders are bound to acknowledge and implement direction from the DM leadership in all matters pertaining to the DM project. The DM Project Manager and DM Project Scientist have direct input into the performance appraisals of the Institution Project Manager and Scientific/Engineering Lead.

A DMO Discussion and Decision Making Process

The Escalation process only occurs when the issue cannot be resolved within the DMO, i.e. when the following internal discussion and decision making process has failed to yield a de-

cision. Empowerment All DMO team members are empowered by the DM Project Manager (PM) and Project Scientist (PS) to make decisions on any DM-internal matter, including technical/algorithm issues, process improvements, tool choices, etc., when: A) they are willing and able to do the work to implement the decision or with people who agree with the team member, B) they (collectively) are willing and able to fix any problems if it goes wrong, and C) they believe that all affected parties (including your immediate manager) would not seriously object to your decision and implementation. RFC Process If the above three criteria are not met, perhaps because the team member doesn't know all the affected parties or because they don't know their positions, the team member should publish the proposed decision and implementation as a JIRA issue in the Request For Comments (RFC) project with a component of "DM".

It is usually difficult to determine all the affected parties for published package interfaces. Changes to interfaces should thus typically go through this process.

It's a good idea to contact any known affected parties before starting this process to check that the resolution is sensible. The institutional technical manager is always affected, as she or he is responsible for tracking the work schedule. If work for others is being proposed, they are obviously affected. The institutional scientist, the DM System Architect (SA), the DM Interface Scientist (IS), and the DM Project Scientist (PS) are also valuable resources for determining affected parties.

The purpose of an RFC is to inform others about the existence and content of the proposed decision and implementation in order to allow them to evaluate its impact, comment on it, refine it if necessary, and agree (implicitly or explicitly) or object (explicitly) to its execution.

The discussion of the RFC takes place in the medium of the requestor's choosing (e.g., a specific mailing list, the RFC JIRA issue itself, a HipChat room, a convened videocon, some combination of those, etc.), but the requestor should be open to private communications as well.

In the RFC process, the opinions of those who will be doing the work (and fixing any problems if something goes wrong) are given more weight. In some cases, this may mean that the RFC issue's Assignee passes to someone else. The opinions of more senior people or people more experienced in the area should also be given more weight and may also result in the Assignee changing.

The Assignee is responsible for determining when no serious objections remain. In particular, there is no need to call for a formal vote on the (refined) resolution. If no explicit objections have been raised within, typically, 72 hours for "ordinary" issues and 1 week for "major" issues, the Assignee should assume that there are none. This is known as "lazy consensus". When this state has been reached, the Assignee is responsible for ensuring that the final consensus has been recorded in the RFC issue before closing it and proceeding with implementation of the decision.

The requestor must be especially careful about not making irreversible changes in the "lazy consensus" time period unless they are absolutely certain there's a general agreement on the stated course of action. If something is broken, the requestor must be ready to fix it. It is critical to apply sound reasoning and good judgement about what may be acceptable and what might be not. Mistakes will happen; accept that occasionally there will be a requirement to revert an action for which it was thought agreement existed. Exceptions and Appeals Some proposed resolutions may require changes to one or more of the baselined, change-controlled documents describing the Data Management system (those in DocuShare with an LDM- handle or marked as change-controlled in Confluence). Note that major changes to budget or scope will almost certainly affect one or more LDM- documents. In this case only, the DM Technical Control Team (TCT), consisting of the DM PM, PS, SA, and IS, may empanel an ad hoc committee including the lead author of the document and other relevant experts. This committee or the TCT itself must **explicitly** approve the change.

Change-controlled documents with other handles, such as LSE- or LPM-, including inter-subsystem interfaces, have project-wide change control processes. Please consult the DM PM, SA, or IS for more information. At least one member of the DM TCT will read each RFC to determine if it might affect a change-controlled document.

If the DMO team can't converge on a resolution to an RFC that has no serious objections but the requestor still feel that something must be done, the request will be escalated. In most non-trivial cases, they will, with the advice of the SA, empanel a group of experts to which they will delegate the right to make the decision, by voting if need be.

Formalities For project management purposes, RFCs are formally proposals made to the DM PM and PS who by default are responsible for everything in DM (they "own" all problems). As owners, they have the final word in accepting or rejecting all proposals. Functionally, they delegate that ownership ? the right and responsibility to make decisions – to others within the team (e.g. the SA, IS, group leads, etc.) who are expected to delegate it even further. Notifying the institutional technical manager about an RFC serves to inform the DM PM.

B Pre-Construction Phase Organization

This section is historical in nature and describes the DM Organization as it has evolved during the Conceptual, Preliminary, and Final Design Phases prior to Construction.

B.1 Conceptual Design Phase

As shown in Figure 3¹, during the Conceptual Design Phase, the Project Manager and Project Scientist jointly supervise several Working Group, which are aligned by functional area. The Working Group Leads are strictly technical leaders responsible for specific work areas, and have no budgetary or schedule authority. Their primary work is the development of requirements and architecture in each of these functional areas.

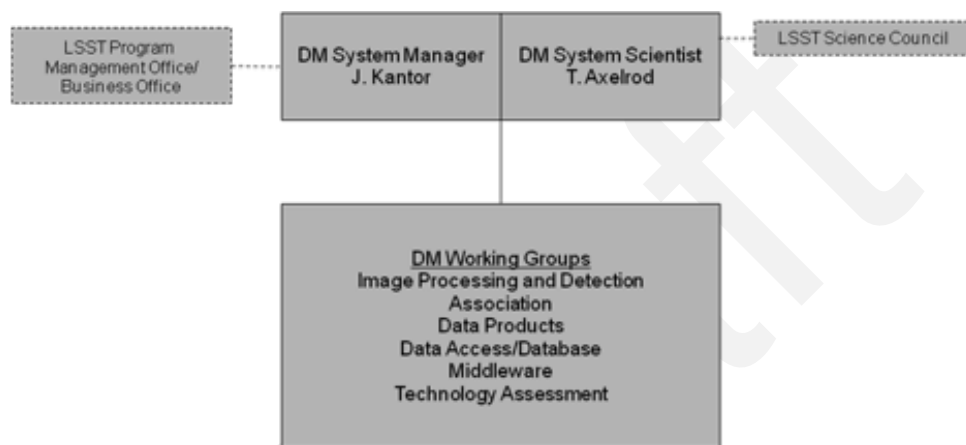


FIGURE 3: Data Management Conceptual Design Phase Organization

B.2 Preliminary Design Phase

The organization transitions to a more complex structure during Preliminary Design, as the role of each DM partner institution is solidified, and D&D prototype development projects called Data Challenges become a primary organizing/tasking vehicle for D&D work. The Working Groups still remain and play a cross-institutional functional role in each area, but there is a more formal structure for work allocation and responsibility, as shown in Figure 4.

In this phase, new positions reporting to the Project Manager and Project Scientist are added. First, there is the DM System QA and Test Lead, who assists the Project Manager in preparation of formal plans, processes, and environments for software development, integration, and test. A Data Management System Architect supports the Project Manager and Project Scientist in matters related to LSST system engineering, including other subsystem interfaces, overall LSST system control, real-time external system interfaces (e.g. alerting), simulation, and end-to-end system engineering for quality assessment. Finally, temporary Data Challenge Teams consisting of astronomers and engineers are formed for prototyping specific critical design aspects that have high risk (e.g. precursor and simulated data processing and prototype work, research and

¹LSST Science Council no longer exists. It has been replaced by the LSST Project Science Team and the LSST Science Advisory Committee

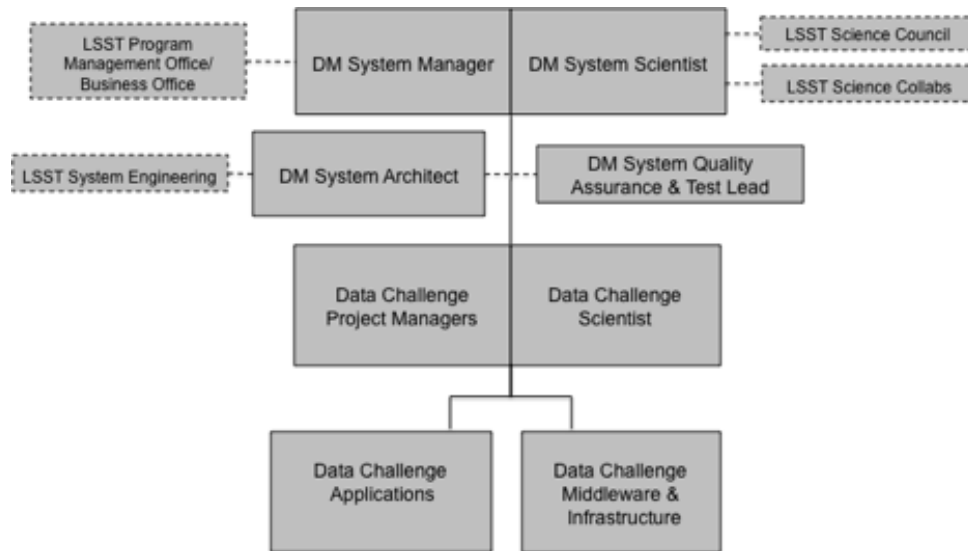


FIGURE 4: Data Management Preliminary Design Phase Organization

development of new algorithms for moving object detection or data distribution). Each Data Challenge Team has a designated Project Manager who reports to the Project Manager and Scientist who reports to the Project Scientist for the duration of the Data Challenge.

B.3 Final Design Phase

During Final Design Phase, the organization structure transitions to one that will persist for the remainder of the period in which the DM System is developed and commissioned, up to the start of LSST Observatory operations. As shown in Figure 5, the organization now features lead institutions, each with responsibility for major element of the DM System (Level 2 Work Breakdown Structure elements) and Project Manager. For example, during Final Design, the Processing Services/Tools and Archive Site Manager and Team at NCSA will be conducting prototyping activities in computing, data communications, and data storage to select and verify the ability of System technologies to support the LSST requirements. They will also be involved in creating a supporting infrastructure for the DM Systems. During Construction before the LSST first light time frame, these resources will be focused on implementation of the selected technologies. In order to ensure that team functions as one integrated project, the institutions coordinate support by other lead institution team members directly through this organizational structure, as well as via a number of cross-organizational bodies (described later in this document). Also, due to the span of the organization, the DM Project Manager will be supported by one of the lead institution Project Managers as a Deputy Project Manager in these phases.

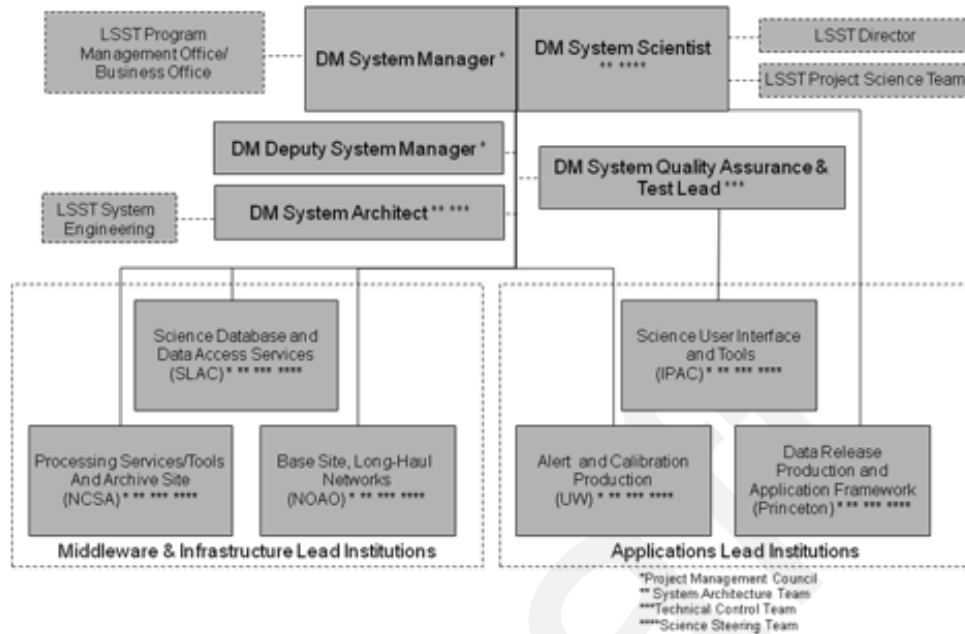


FIGURE 5: Data Management Final Design Phase Organization

C References

D Acronyms

The following table has been generated from the on-line Gaia acronym list:

Acronym	Description
CAM	CAMera
CCB	Configuration Control Board
CR	Change Request
DC	Data Centre
DM	Data Management
DMLT	DM Leadership Team
DMO	Data Management Organisation
DMS	Document Management System (ESA)
DMSR	DM System Requirements
ESA	European Space Agency

ESAC	European Space Astronomy Centre (VilSpa)
ICD	Interface Control Document
JIRA	issue tracking product (not an acronym, but a truncation of Gojira, the Japanese name for Godzilla)
LDM	Light Data Management
LPM	LSST Project Management (Document Handle)
LSE	LSST System Engineering (Document Handle)
LSST	Large-aperture Synoptic Survey Telescope
NCSA	National Center for Supercomputing Applications
NSF	National Science Foundation
PM	Project Manager
PS	Project Scientist
PST	Processing Support Tool
QA	Quality Assurance
RFC	Request for Comments
SA	Science Alert(s)
SAT	Science Archives Team (at ESAC)
SEMP	System Engineering Management Plan
TCAM	Technical Control/Account Manager
TCT	Technical Control Team
WBS	Work Breakdown Structure