LARGE SYNOPTIC SURVEY TELESCOPE

Large Synoptic Survey Telescope (LSST)

Data Management Organization and Management

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Abstract

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

Change Record

Version	Date	Description	Owner name
1	2004-06-23	Initial version	JK
2	2015-03-11	Updated with new RFC process, realignment of TCT, SAT, DMLT - other versions in between	JK
2	2017-01-09	Update in TeX	WOM,MJ

Contents

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 statement

Stand up operable, maintainable, quality services to deliver high-quality LSST data products for science and education, all on time and within reasonable cost.

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-time frame 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 organisations participating in LSST Data Management initiatives.

The DM organization goals in selecting and, where necessary, developing LSST software solutions are:

- Acquire and/or develop solutions: To achieve its mission, LSST DM subsystem prefers to acquire and configure existing, off-the-shelf, solutions. Where no satisfactory off-the-shelf solutions are available, DM develops the software and hardware systems necessary to:
  - Enable the generation of LSST data products at the LSST Archive and Satellite processing center, and
  - Enable the the serving of LSST data products from the two LSST DACs (one in the U.S., and one in Chile).
- Maintain coherent architecture: DM software architecture is actively managed at the subsystem level. A well engineered, and cleanly designed codebase is less buggy, more maintainable, and makes developers who work on it more productive. Where there is no significant impact on capabilities, budget, or schedule, LSST DM prefers to acquire and/or develop reusable, open source, solutions.
- Support reproducibility and insight into algorithms: Other than when prohibited by licensing, security, or other similar considerations, DM makes all newly developed source code public, especially the Science Pipelines code. Our primary goal in publicising the code is to simplify reproducibility of LSST data products, and provide insight into algorithms used. The software is to be documented to achieve those goals.
- Opportunities beyond LSST: LSST DM codes may be of interest and (re)used beyond the LSST project (e.g., by other survey projects, or individual LSST end-users). While enabling or supporting such applications goes beyond LSST's construction requirements, cost and schedule-neutral technical and programmatic options that do not preclude them and allow for future generalisation should be strongly preferred.

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.

2.1 Document Management

DM documents will follow the System Engineering Guidelines of LSST. PDF versions of released documents shall be put in Docushare in accordance with the project Document management plan LPM-51.

The Document Tree for DM is shown in Figure 2, it is not exhaustive but gives a high level orientation for the main documents in DM and how they relate to each other.

2.1.1 Draft Documents

Draft DM documents will be kept in GitHub. A single repository per document will be maintained with the head revision containing the *released* version which should match the version

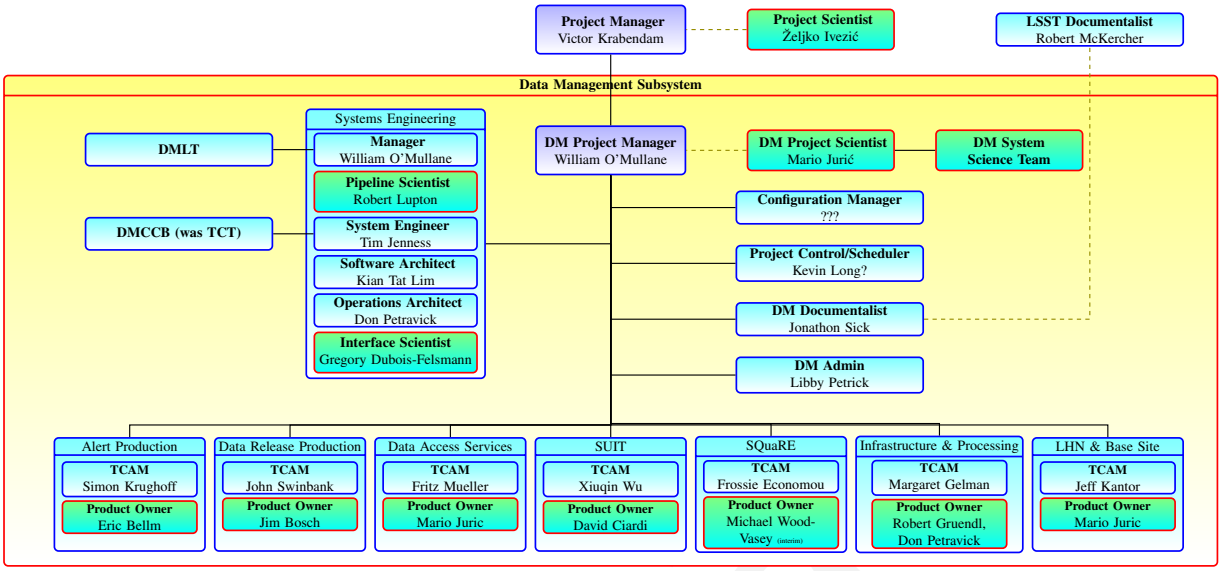

FIGURE 1: DM organisation with Scientists in Green.

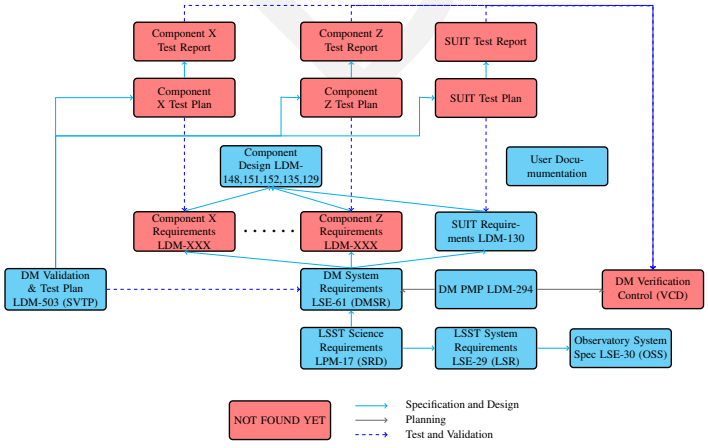

FIGURE 2: Outline of the documentation tree for DM relating the high level documents to each other.

on docushare.

In addition each repository will be included as a *submodule* of a single dm-docs git repository namely`https://github.com/lsst-dm/dm-docs`. [1]

An LSST document class fro LaTeX is provided for TeX documents, to use this texmf must be set up to include the texmf folder form the repository. See `https://github.com/lsst/lsst-texmf/` to set this up.

End user documentation will most likely and appropriately be web based and the scheme for that is described in [**?**].

2.2 Configuration Control

Configuration control of documents is dealt with in Section 2.1. Here we consider more the operational systems and software configuration control.

2.2.1 Software Configuration Control

We should have a configuration management plan covering this.

DM follows a git based versioning system based on public git repositories and the approach is covered in the developer guide `https://developer.lsst.io/`. The master branch is the stable code with development done in *ticket* branches (named with the id of the corresponding Jira Ticket describing the work. Once reviewed a branch is merged to master.[2]

As we approach commissioning and operations DM will have a much stricter configuration control. At this point there will be a version of the software which may need urgent patching, a next candidate release version of the software, and the master. A patch to the operational version will require the same fix to be made in the two other versions. Th's role of the Con-

[1] Use of Google Docs or confluence is tolerated but final delivered documents should look like LSST docs so either done with TeX or Word Templates. The Google doc or Confluence page should then be erased with a pointer to the baseline document. This should be in github.

[2] LSE-14 seem out of date and should be updated or revoked - titled a guideline it seems inappropriate as an LSE.

figuration Control Board (CCB) becomes very important at this point to ensure only essential fixes make it to the live system as patches and that required features are included in planned releases.

We can not escape the fact that we will have multiple code branches to maintain in operations which will lead to an increase in work load. Hence one should consider that perhaps more manpower may be needed in commissioning to cope with urgent software fixes while continuing development. The other consideration would be that features to be developed post commissioning will probably be delayed more than one may think, as maintenance will take priority.[3]

2.2.2 Hardware Configuration Control

On the hardware side we have multiple configurable items, we need to control which versions of software are on which machines. These days tooling like Puppet make this reasonably painless. Still the configuration must be carefully controlled to ensure reproducible deployments providing correct and reproducible results. The exact set of released software and other tools on each system should be held in a configuration item list. Changes to the configuration should be endorsed by the CCB.

2.3 Risk Management

Risks will be dealt with within the project framework defined in LPM-20, the specific DM process for risk assessment is defined in LDM-512.

2.4 Quality Assurance

In accordance with the project QA plan LPM-55 ..

2.5 Verification and Validation

We intend to verify and validate as much of DM as we can before commissioning and operations. This will be achieved through testing and operations rehearsals/data challenges. The

[3] WOM identifies this as the maintenance surge.

Verification and Validation approach is detailed in [LDM-503]

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 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 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 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 or 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 Requirements Engineer

With the system engineering team Section 4.2 and in close coordination with the software architect (Section **??** and the system engineer Section **??** look after the baseline requirements for DM..

3.9 Operations Architect

How do we deploy and run everything .. Ops Architect will help us find out.

3.10 Software Architect

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 ?

3.11 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

The System engineering team is lead by the DM Project Manager and looks after all aspect of system engineering. It is comprised of not only a System Engineer (Section **??**) but also the Requirements Engineer (Section **??**, Software Architect (Section **??**), Operations Architect (Section **??**) and the Pipeline Scientist (Section **??**).

While the product owners help DM to create the correct product , fit for purpose, the System engineering team must ensure we do it correctly. This group concerns its self with system wide decisions on architecture and software engineering.

Within this group we must:

- Formalise the Product list/tree for DM, these are not the data products but the DM software and systems which produce the products.
- Formalise the documentation tree for DM - which documents need to be produced for each product.
- Agree how to trace the baseline requirements verification and validation status.
- ...

Some of these tasks are obviously delegated tot he individuals in the group. These individuals also are the conduit to the rest of the DM team to raise ideas/issues with the engineering approach.

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 Team (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 baseline 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 3 depicts the escalation path for such problem resolution.

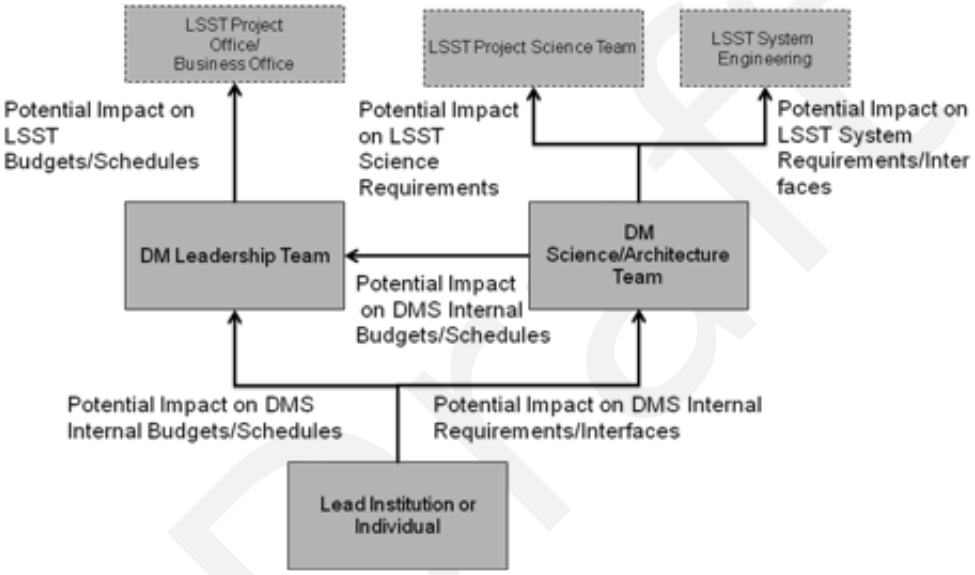

FIGURE 3: Problem Management/Escalation

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 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. SQuaRE's activities span processes and environments for software development, integration test and distribution. SQuaRE 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 SQuaRE 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 SQuaRE 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 decision. 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

memaber, 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 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 4 [4] , 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.

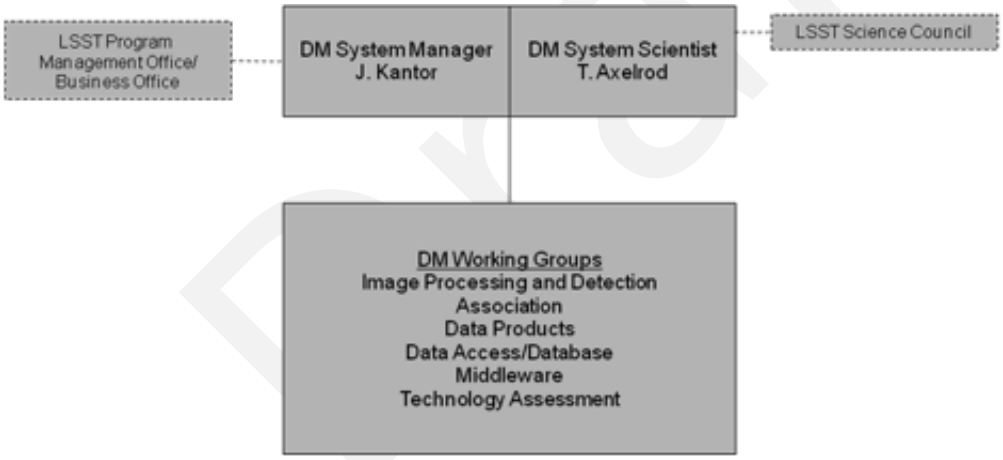

FIGURE 4: Data Management Conceptual Design Phase Organization

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 5.

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

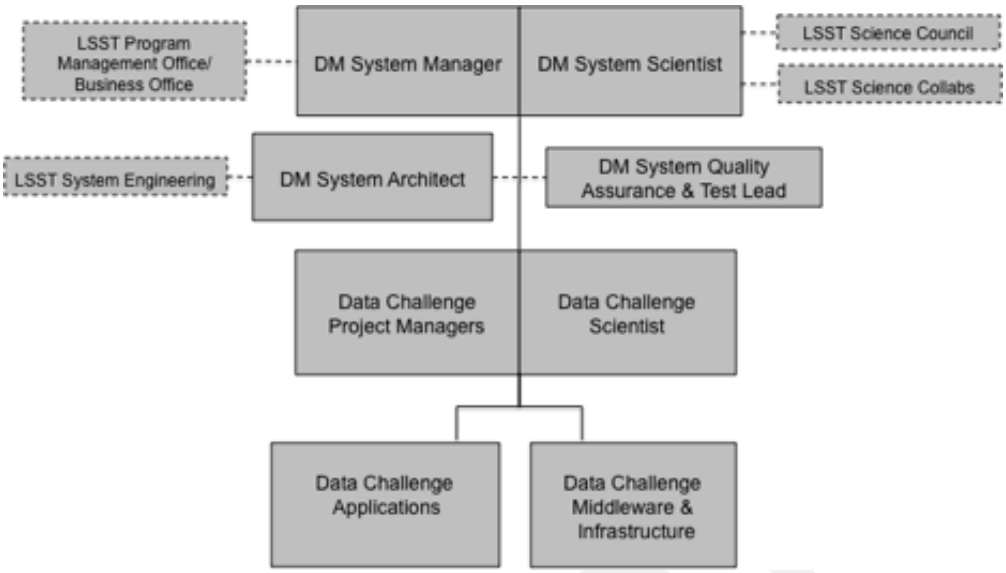

FIGURE 5: Data Management Preliminary Design Phase Organization

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 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 6, 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.

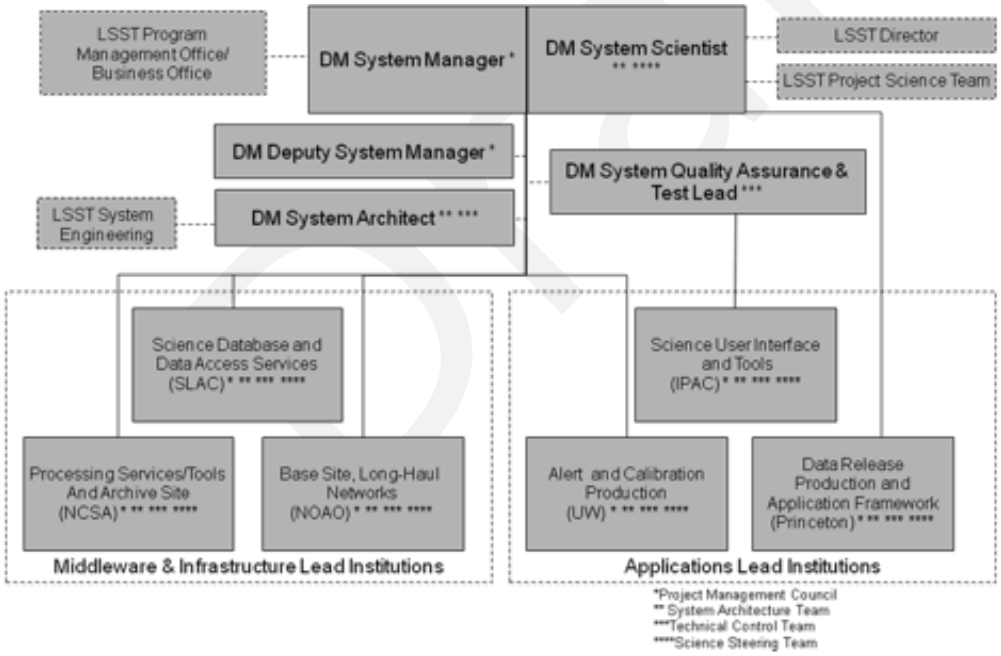

FIGURE 6: Data Management Final Design Phase Organization

C References

[1] **[LDM-512]**, Jenness, T., O'Mullane, W., 2017, *Data Management Risk Assessment Process*, LDM-512, URL https://ls.st/LDM-512

[2] **[LPM-20]**, Krabbendam, V., Selvy, B., 2015, *Risk & Opportunity Management Plan*, LPM-20, URL https://ls.st/LPM-20

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[4] **[LDM-503]**, O'Mullane, W., Jurić, M., Economou, F., 2017, *Data Management Test, Verificaiton and Validation Plan*, LDM-503, URL https://ls.st/LDM-503

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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
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