LARGE SYNOPTIC SURVEY TELESCOPE

Large Synoptic Survey Telescope (LSST)

Data Management Organization and Management

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LDM-294

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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

Data Management Organization and Management

1 Introduction

1.1 Purpose

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

LSST Data Management 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 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.

Background decision material on choices made in DM will be documented in technical notes (DMTN) which will be lodged in DocuShare (see Section 3.1).

2 Data Management Conceptual Architecture

The DM Subsystem Architecture is detailed in LDM-148. A few of the higher level diagrams are reproduced here to orientate the reader within DM.

During Operations, components of the DM Subsystem will be installed and run in multiple locations. These include:

- The Commissioning Cluster, which may be physically at NCSA in Urbana-Champaign
- The main centre in NCSA enclave in Urbana-Champaign
- The US Data Access Centre (DAC), also at NCSA in Urbana-Champaign
- The Chilean DAC in the Base Facility in La Serena Chile
- The Satellite Processing Centre at CC-IN2P3 in Lyon, France

Figure 1 shows the various DM components which will be used in operations and the physical compute environments in which they will be deployed. Bulk data storage and transport between components is provided by the Data Backbone. This complex piece of infrastructure is displayed in Figure 3.

Science users will access the data products produced by LSST through the Science Platform, as shown in Figure 2.

Figure 4 shows the common infrastructure and services layer which underlies the compute environments. This does not list specific technologies for management/monitoring, provisioning/deployment, or workload/workflow — these are still under development — but consider industry-standard tools such as Nagios, Puppet/vSphere/OpenStack/Kubernetes, and Pegasus.

2.1 External Interfaces

The DM external interfaces are controlled by the following ICDs:

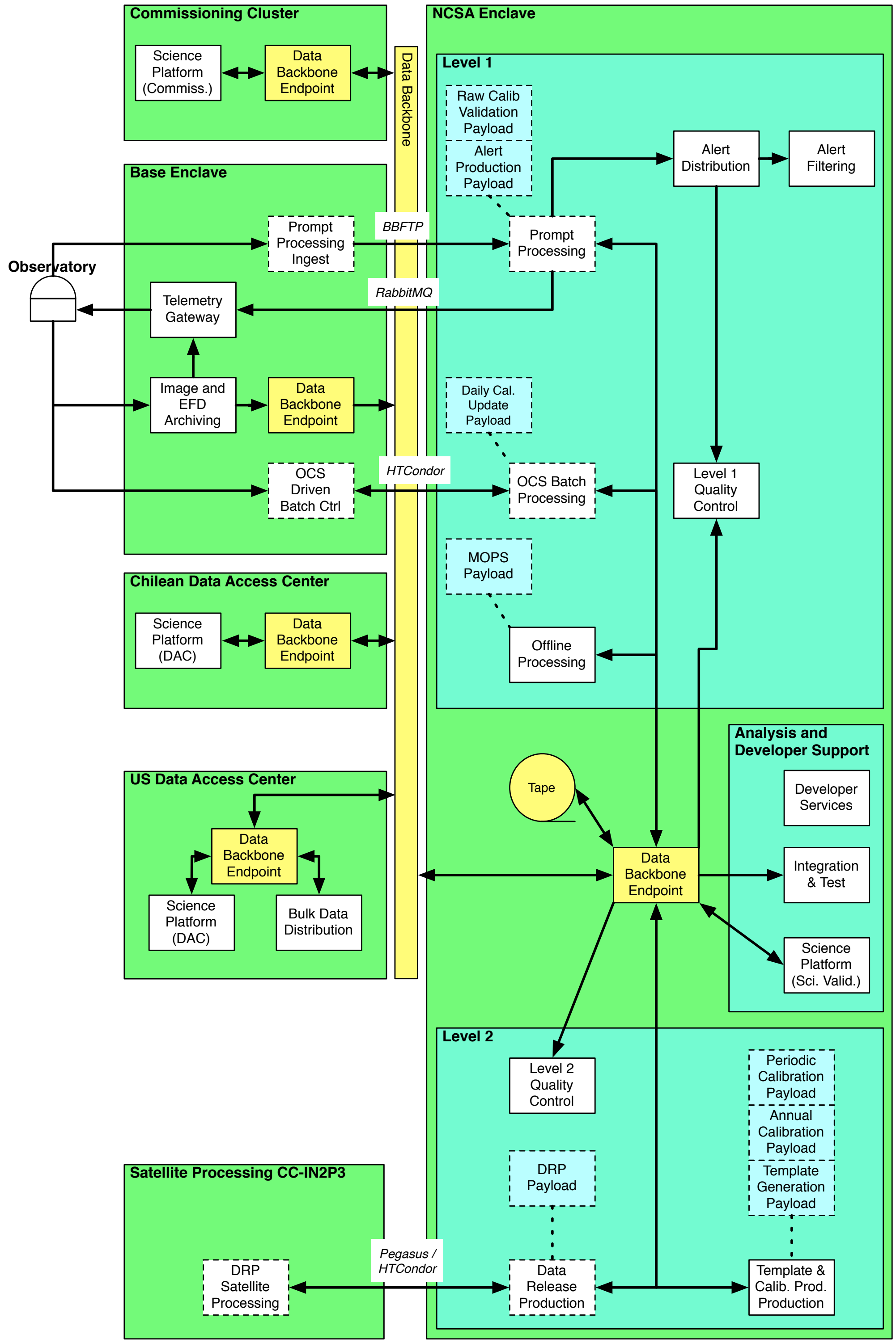

FIGURE 1: DM components as deployed during Operations. Where components are deploed in multiple locations, the connections between them are labelled with the relevant communication protocols. Science payloads are shown in blue.

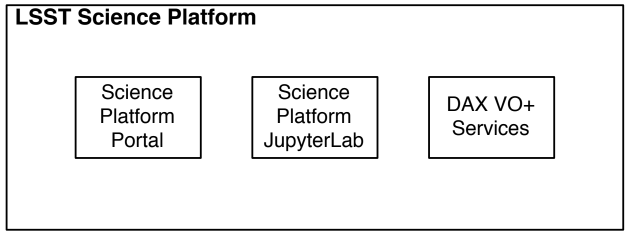

FIGURE 2: The sub-components of the Science Platform.

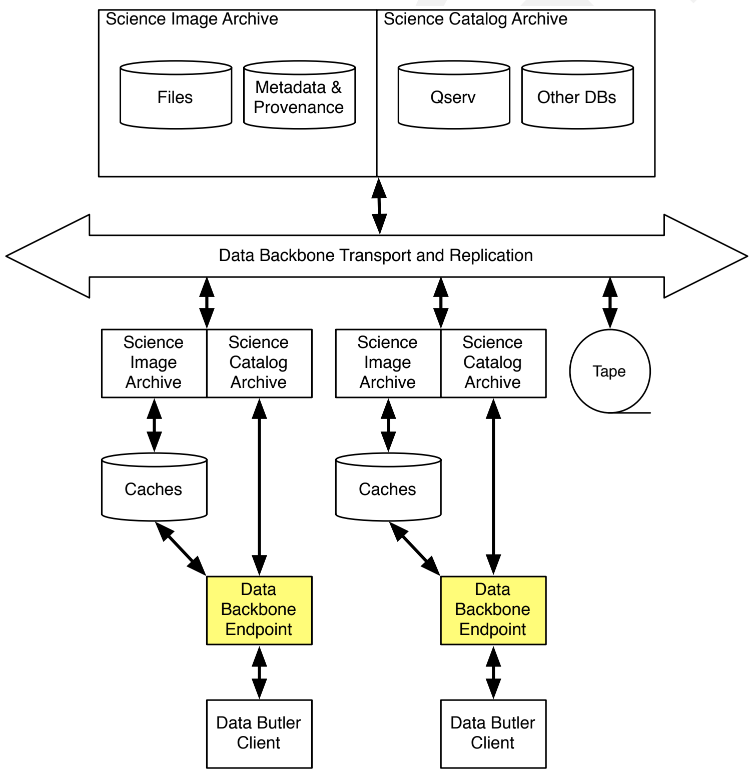

FIGURE 3: The Data Backbone links all the physical components of DM.

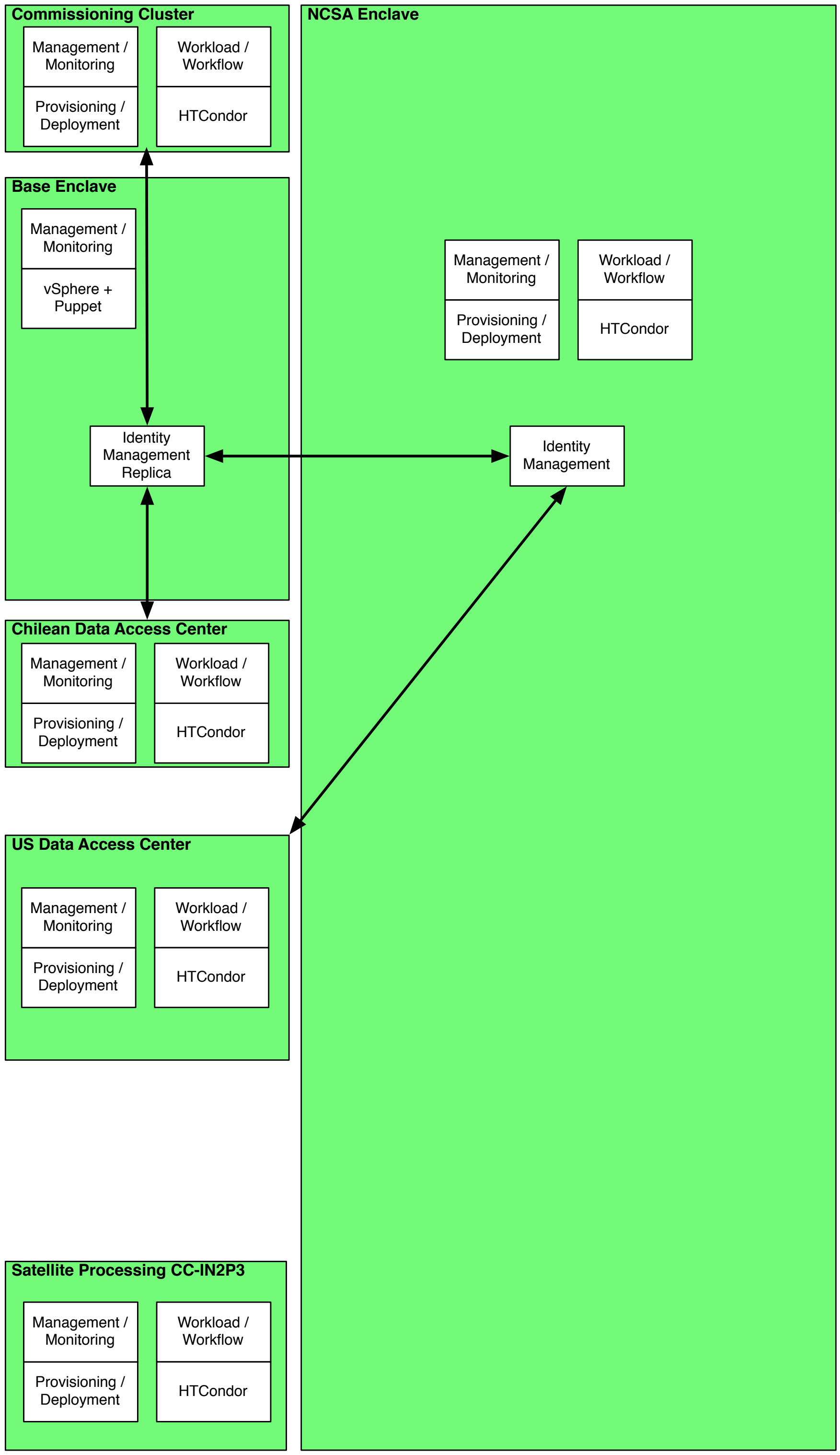

FIGURE 4: Common infrastructure services available at each DM location.

LSE-68 Data Acquisition Interface between Data Management and Camera

LSE-69 Interface between the Camera and Data Management

LSE-72 OCS Command Dictionary for Data Management

LSE-75 Control System Interfaces between the Telescope and Data Management

LSE-76 Infrastructure Interfaces between Summit Facility and Data Management

LSE-77 Infrastructure Interfaces between Base Facility and Data Management

LSE-130 List of Data Items to be Exchanged Between the Camera and Data Management

LSE-131 Data Management Interface Requirements to Support Education and Public Outreach

LSE-140 Auxiliary Instrumentation Interface between Data Management and Telescope

2.1.1 Auxiliary data in DM

Certain tasks in DM rely on external catalogues and other information. Currently we believe we need:

1. Gaia catalogue (Release 2) as a photometry baseline.

3 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.

The DM Project Manager (William O'Mullane), Deputy Project Manger (John Swinbank) and DM Project Scientist (Mario Jurić), 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 organisations 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 5, the organization now features major products each with a product owner relating to a major element of the DM Subsystem (Level 2 Work Breakdown Structure elements).

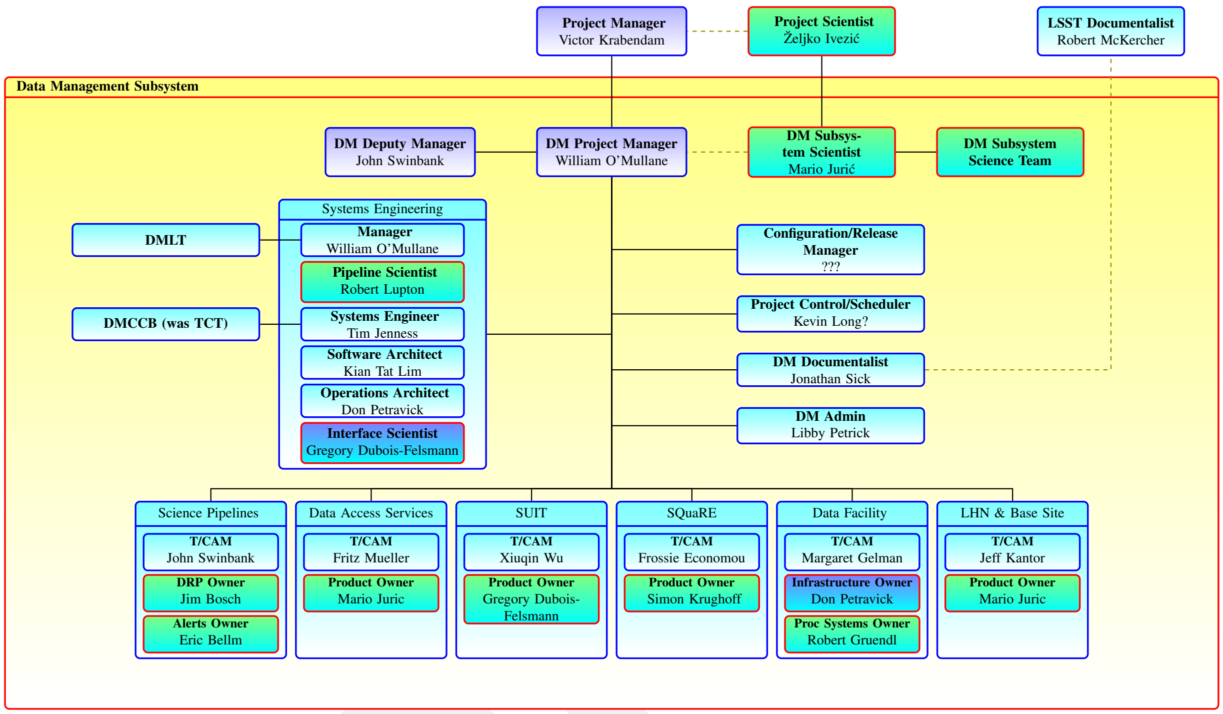

FIGURE 5: DM organisation with Scientists in Green.

3.1 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's Document Management Plan [LPM-51]. LPM level documents are released on agreement of the DMCCB (Section 7.4), uncontrolled documents such as technotes may be released when the author decides it is appropriate or they are asked to release it by the Project Manager.

The Document Tree for DM is shown in Figure 6, it is not exhaustive but gives a high level orientation for the main documents in DM and how they relate to each other.

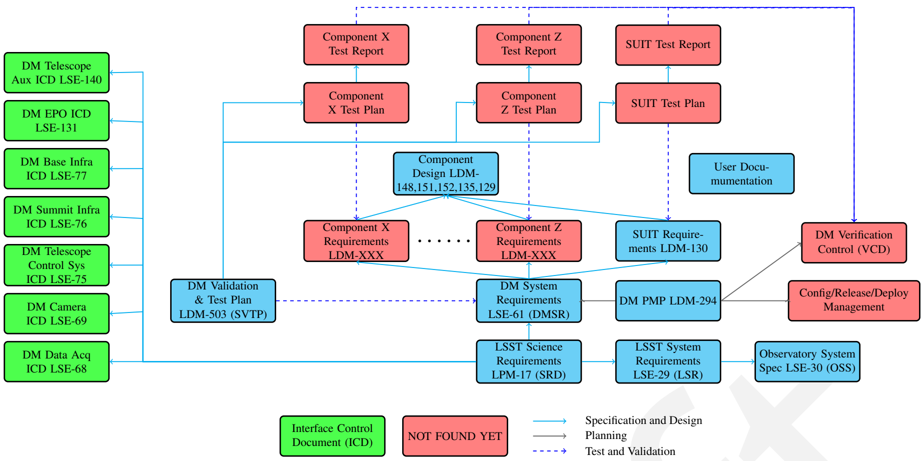

FIGURE 6: Outline of the documentation tree for DM software relating the high level documents to each other.

Need a DOC tree for End User Documentation - Jonathan ?

Need a DOC tree for Hardware/Services - Margaret

3.1.1 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 on docushare. Each repository will be included as a *submodule* of a single git repository located at `https://github.com/lsst-dm/dm-docs`.

Use of Google Docs or confluence is tolerated but final delivered documents must conform to the standard LSST format, and hence either produced with LaTeX, using the lsst-texmf package[1], or Word, using the appropriate LSST template [Document-9224, Document-11920]. The precursor document should then be erased with a pointer to the baseline document, stored in GitHub.

End user documentation will most likely and appropriately be web based and the scheme for that is described in LDM-493.

[1] `https://lsst-texmf.lsst.io`

3.2 Configuration Control

Configuration control of documents is dealt with in Section 3.1. Here we consider more the operational systems and software configuration control.

3.2.1 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. The role of the DM Change Control Board (DMCCB; Section 7.4) 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 cannot 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] LSE-14 seem out of date and should be updated or revoked - titled a guideline it seems inappropriate as an LSE.

[3] WOM identifies this as the maintenance surge.

3.2.2 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 DMCCB.

The sizing model for compute hardware purchasing is detailed in LDM-151 and **?** .

3.3 Risk Management

Risks will be dealt with within the LSST Project framework as defined in LPM-20. Specific DM processes for risk assessment are elaborated in LDM-512.

3.4 Quality Assurance

In accordance with the project QA plan LPM-55 we will perform QA on the software products. This work will mainly be carried out by SQuaRE (Section 8.1.1). Quality assurance here means compliance with project guidelines for production, in out case of software production. A part of this is to have a verification/validation plan(s) which in and of itself is a major task (see Section 3.6).

3.5 Action item control

Actions in DM are tracked as Jira issues an periodically reviewed at DMLT meetings.

3.6 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 verification and validation approach is detailed in LDM-503 including a high level test schedule.

4 Project Controls

DM follows the LSST project controls system, as described in LPM-98. Specific DM processes for project planning are elaborated in LDM-472.

The LSST Project Controller is Kevin Long. He is responsible for the PMCS and, in particular, for ensuring that DM properly complies with our earned value management requirements. He is the first point of contact for all questions about the PMCS system.

4.1 Schedule and control

Covered in LP-98 ?

4.2 Work Breakdown Structure

The DM WBS is laid out in LPM-43 with definitions provided in LPM-44.

The WBS provides a hierarchical index of all hardware, software, services, and other deliverables which are required to complete the LSST Project. It consists of alphanumeric strings separated by periods. The first component is always "1", referring the LSST Construction Project. "02C" in the second component corresponds to Data Management Construction. Subdivisions thereof are indicated by further digits. These subdivisions correspond to teams within the DM project. The top level WBS elements are mapped to the lead institutes in Table 2. The various groups involved in the WBS are briefly described in Section 7.

5 Products

The products of DM are not the data products defined in LSE-163, rather they are the artefacts, systems and Services, we need to produce those produces. Figure 7 is an initial attempt to define the product tree for DM.

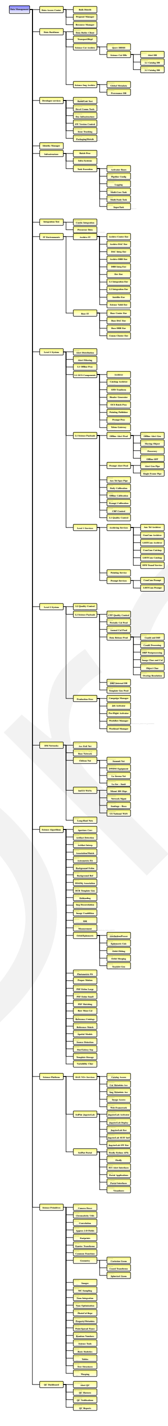

FIGURE 7: DM product tree.

TABLE 2: DM top level Work Breakdown Structure

WBS	Description	Lead Institution
1.02C.01	System Management	LSST
1.02C.02	Systems Engineering	LSST
1.02C.03	Alert Production	University of Washington
1.02C.04	Data Release Production	Princeton University
1.02C.05	Science User Interface	Caltech IPAC
1.02C.06	Science Data Archive	SLAC
1.02C.07	Processing Control & Site Infrastructure	NCSA
1.02C.08	International Communications. & Base Site	NCSA & LSST
1.02C.09	Systems Integration & Test	NCSA & LSST
1.02C.10	Science Quality & Reliability Engineering	LSST

6 Roles in Data Management

This section describes the responsibilities associated with the roles shown in Figure 5.

6.1 DM Project Manager (DMPM)

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 to be considered for approval. 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 (Section 7.3)

6.2 DM Deputy Project Manager (DDMPM)

The PM and deputy will work together on the general management of DM and any specific PM tasks may be delegated to the deputy as needed and agreed. In the absence of the PM the deputy carries full authority and decision making powers of the PM. The DM Project Manager will keep the Deputy Project Manager informed of all DM situations such that the deputy may effectively act in place of the Project Manager when absent.

6.3 DM Subsystem Scientist (DMSS)

The DM Subsystem Scientist (DMSS) has the ultimate responsibility for ensuring DM initiatives provide solutions that meet the overall LSST science goals. As such, they lead the definition and understanding of the science goals and deliverables of the LSST Data Management System, and are accountable for communicating these to the DM engineering team.

The DM Subsystem Scientist reports to the LSST Project Scientist. The DMSS are a member of the LSST Change Control Board and the Project Science Team. They chair and direct the work of the DM System Science Team (Section 7.1).

Specific responsibilities and authorities include (**cite the project-level R2A2 document, once issued**):

- Communicates with DM science stakeholders (LSST Project Scientist and Team, advisory bodies, the science community) to understand their needs and identifies aspects to be satisfied by the DM Subsystem.
- Develops, maintains, and articulates the vision of DM products and services responsive to stakeholder needs.
- Works with the LSST Project Scientist to communicate the DM System vision to DM stakeholders. Works with the DM Project Manager to communicate and articulate the DM

System vision and requirements to the DM construction team.

- Regularly monitors DM construction team progress and provides feedback to the DM Project Manager to ensure the continual understanding of and adherence to the DM vision, requirements, and priorities.
- Develops and/or evaluates proposed changes to DM deliverables driven by schedule, budget, or other constraints.
- Provides advice to the DM Project Manager on science-driven prioritization of construction activities.
- Validates the science quality of DM deliverables and the capability of all elements of the DM System to achieve LSST science goals.
- Serves as Data Management Liaison as requested by LSST Science Collaborations
- Provides safe, effective, efficient operations in a respectful work environment.

Specific authorities include (**cite the project-level R2A2 document, once issued**):

- Defines the vision and high-level requirements of the DM products and services required to deliver on LSST science goals.
- Defines the science acceptance criteria for DM deliverables (both final and intermediate) and validates that they have been met (Science Validation).
- Hires or appoints DM System Science Team staff and other direct reports and defines their responsibilities.
- Advises and consents to the appointments of institutional DM Science Leads.
- Delegates authority and responsibility as appropriate to institutional Science Leads and other members of the DM System Science Team.
- Represents and speaks for the LSST Data Management.
- Convenes and/or participates in all DM reviews.
- Co-Chairs the DM Leadership Team

6.4 Project Controller/Scheduler

The DM Project Controller is responsible for integrating DM's agile planning process with the LSST Project Management and Control System (PMCS). Specific responsibilities include:

- Assist T/CAMs in developing the DM plan
- Synchronize the DM plan, managed as per LDM-472, with the LSST PMCS
- Ensure that the plan is kept up-to-date and milestones are properly tracked
- Coordinate sprints, ensuring that appropriate story points are allocated and tracked
- Create reports, Gantt charts and figures as requested by the DMPM

6.5 Product Owner

A product owner is responsible for the quality and acceptance of a particular product. 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.

6.6 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 7.2).

- 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.

6.7 Systems Engineer

With the System Engineering Team (Section 7.2) the Systems Engineer owns the DM entries in the risk register and is generally in charge of the *process* of building DM products.

As such, the Systems Engineer is responsible for managing requirements as they pertain to DM. This includes:

- Update and ensure traceability of the high level design & requirements documents: DMSR (LSE-61), OSS (LSE-30), and LSR (LSE-29)
- Overseework on lower level requirements documents
- Ensure that the system is appropriately modelled in terms of e.g. drawings, design documentation, etc
- Ensure that solid verification plans and standards are established within DM

In addition, the Systems Engineer is responsible for the process to define & maintain DM interfaces (internal and external)

- Define and enforce standards for internal interfaces
- Direct the Interface Scientist's (Section 6.8) work on external ICDs

The Systems Engineer shall chair the DM Change Control Board (Section 7.4)

- Organise DMCCB processes so that the change control process runs smoothly
- Identify RFCs requiring DMCCB attention
- Shepherd RFCs through change control
- Call and chair DMCCB meetings, ensuring that decisions are made and recorded

Finally, the System Engineer represents DM on the LSST CCB.

6.8 DM Interface Scientist (DMIS)

The DM Interface Scientist is responsible for all internal and external interfaces to the DM Subsystem. This includes ensuring that appropriate tests for those interfaces are defined.

6.9 Requirements Engineer

With the System Engineering Team (Section 7.2) and in close coordination with the Software Architect (Section 6.10) and the Systems Engineer (Section 6.7) looks after the baseline requirements for DM.

6.10 Software Architect

The Software Architect is responsible for the overall design of the DM *software* system. Specific responsibilities include:

- Define the overall architecture of the system and ensuring that all products integrate to form a coherent whole
- Select and advocate appropriate software engineering techniques
- Choose the technologies which are used within the codebase
- Minimize the exposure of DM to volatile external dependencies

The Software Architect will work closely with the Systems Engineer (Section 6.7) to ensure that processes are in place for tracing requirements to the codebase and providing hooks to ensure that requirement verification is possible.

6.11 Operations Architect

Margaret or Don perhaps some text here ...

The DM Operations Architect is responsible for ensuring that all elements of the DM Subsystem, including operations teams, infrastructure, middleware, applications, and interfaces, come together to form an operable system.

Specific responsibilities include:

- Set up and coordinate operations rehearsals
- Ensure 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
- Serve as a member of the LSST System Engineering Team

6.12 Configuration Manager (CM)

The DM Configuration Manager (CM) is responsible for Configuration Management activities inside DM and NCSA(?). The following list is not exhaustive, but is intended as a guideline to the CM activities:

- Ensure that Configuration Management Plan (CMP) is correctly applied and provide appropriate reasons in case of non conformance's
- Define which Configuration Items are to be managed in the Configuration Item List
- Define the Product Baseline

- Support changes to Configuration Items within the DMCCB
- Manage the delivery of software products
- Maintain the Configuration Item List
- Manage the configuration control resources used by DM
- Maintain an awareness of the relationship between the elements of the Product Baseline (in order for instance to be able to answer the question: "What is the environment and which software is installed?")
- Check that the Product Assurance and CMP procedures are correctly applied when Configuration Items are changed
- Participate in DMCCB activities

The Configuration Manager is the secretary of the CCB and works with the support of the Scientific and Technical Leaders and participates in the CCB monitoring the development and change control process.

6.12.1 Configuration Item List

The Configuration Item List (CIL) is the list of items that are maintained under configuration control. CUs and DPC need to report their configuration items in the CIL with an adequate level of details. CIL is part of the development plan but may be written in a separate document to which the development plan refers.

The Configuration Manager in charge has to identify the configuration items to include in the CIL, with the help of the technical leader and to maintain it when changes to the configuration items happen.

6.12.2 Release management

In DM usually each product will be released once per cycle. Additional releases may be done in case of bug fixing, urgent issues, or in case that the previous one is incomplete. In case of longer cycles, intermediate major releases can be done.

Each release needs to be identified with:

- Configuration Item
- Documentation:
  User Manual: to be updated each major release
  Requirements Specification: to be updated each major release
  Test Specification: to be updated each major release
  Release Note: new document each major release, updated for patch releases
  Test Report: new document each major release, updated for patch releases
- Latest Release in the `master` branch in GitHub.

This information identifies a product baseline.

The product manager is in charge of preparing the release. After CCB approval, the release will be delivered to NCSA.

6.12.3 Configuration Baseline

A Configuration Baseline (CB) represents the approved status of the project at key milestones like formal review or at the beginning of test activities.

Configuration Baselines are applicable to hardware and software, and will include the documents that describe the CIs and their status.

6.13 Lead Institution Senior Positions

Each Lead Institution (as defined in Section 8; see also Table 2) has a T/CAM and Scientific or Engineering Lead, who jointly have overall responsibility for a broad area of DM work, typically a Work Breakdown Structure (WBS) Level 2 element. They are supervisors of the team at their institution, with roles broadly analogous to those of the DM Project Manager and Project Scientist.

6.13.1 Technical/Control Account Manager (T/CAM)

Technical/Control Account Managers have managerial and financial responsibility for the engineering teams within DM. Each T/CAM is responsible for a specific set of WBS elements. Their detailed responsibilities include:

- Develop, resource load, and maintain the plan for executing the DM construction project within the scope of their WBS
- Synchronize the constuction schedule with development in WBS elements managed by other T/CAMs
- Maintain the budget for their WBS and ensuring that all work undertaken is charged to the correct accounts
- Work with the relevant Science Leads and Product Owners (Section 6.5) to devleop the detailed plan for each cycle and sprint as the occur
- Work with the DM Project Controller (Section 6.4) to ensure that all plans and milestones are captured in the LSST Project Controls system
- Perform day-to-day management of staff within their WBS
- Perform the role of "scrum-master" during agile development

6.13.2 Institutional Science/Engineering Lead

The Institutional Science/Engineering Leads serve as product owners (Section 6.5) for the major components of the DM System (Alert Production, Data Release Production, Science User Interface etc).

In addition, they provide scientific and technical expertise to their local engineering teams.

They work with the T/CAM who has managerial responsibility for their product to define the overall construction plan and the detailed cycle plans for DM.

Institutional science leads are members of the DM System Science Team (Section 7.1) and, as such, report to the DM Subsystem Scientist (Section 6.3).

7 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 four primary coordinating bodies to ensure the management, technical, and quality integrity of the DM Subsystem.

7.1 System Science Team

Members of the DM System Science Team (SST) work together to define, maintain, and communicate to the DM System Engineering team a coherent vision of the LSST DM system responsive to the overall LSST Project goals, as well as scientifically validate the as-build system (LDM-503, Section 9.).

7.1.1 Organization and Goals

The System Science Team includes:

- DM Subsystem Scientist (chair)
- DM Science Validation Scientist
- DM Institutional Science Leads
- DM System Science Analysts
- DM Science Pipelines Scientist

The System Science Team has been chartered to:

- Support the DM Subsystem Scientist (as the overall DM Product Owner) in ensuring that Data Management Subsystem's initiatives provide solutions that meet the overall LSST science goals.
- Support the Institutional Science Leads in their roles as Product Owners for elements of the DM system their respective institutions have been tasked to deliver.

- Support the DM Science Validation Scientist, who organizes and coordinates the science validation efforts (LDM-503).
- Guide the work of System Science Analysts, who generally lead and/or execute studies needed to support SST work.
- Provide a venue for communication with the Science Pipelines Scientist, who broadly advises on topics related to the impact of science pipelines on delivered science and vice versa (Section 6.6).

The members of the System Science Team report to the DM Subsystem Scientist and share the following responsibilities:

- To communicate with the science community and internal internal stakeholders to understand their needs, identifying the aspects to be satisfied by the DM Subsystem.
- Liaison with the science collaborations to understand and coordinate any concurrent science investigations relevant to the DM Subsystem.
- Develop, maintain, and articulate the vision of DM-delivered LSST data products and services that is responsive to stakeholder needs, balanced across science areas, well motivated, and scientifically and technologically current.
- Work with the DM Project Manager and DM Technical Managers to communicate and articulate the DM System vision and requirements to the DM engineering team.
- Identify, develop, and champion new scientific opportunities for the LSST DM System, as well as identify risks where possible.
- Develop change proposals and/or evaluate the scientific impact of proposed changes to DM deliverables driven by schedule, budget, or other constraints.
- Lead the Science Verification of the deliverables of the DM subsystem.

7.1.2 Communications

DM System Science Team communication mechanisms are described on the SST Confluence page at `http://ls.st/sst`.

7.2 DM Systems Engineering Team

The Systems Engineering Team is led by the DMPM (§6.1) and looks after all aspects of systems engineering. It is comprised of not only the Systems Engineer (Section 6.7) but also the Requirements Engineer (Section 6.9), Software Architect (Section 6.10), Operations Architect (Section 6.11) and the Pipeline Scientist (Section 6.6).

While the product owners (Section 6.5) help DM to create products, which are fit for purpose, the Systems Engineering Team must ensure we do it correctly. This group concerns its self with (sub)system wide decisions on architecture and software engineering.

The specific tasks of this group include:

- Formalise the product list for DM[4]
- Formalise the documentation tree for DM, defining which documents need to be produced for each product
- Agree the process for tracing the baseline requirements verification and validation status.
- ...

Some of these tasks are will be delegated to individual group members. These individuals also are the conduit to/from the rest of the DM team to raise ideas/issues with the engineering approach.

7.2.1 Communications

The System Engineering Team will only physically meet to discuss specific topics: there will not be a regular meeting of the group outside of the one to one meetings with the DM project manager for the individuals in the group. Discussions will be held via email until in person talks are required.

[4] In this sense, "products" are the software and systems which produce data products, rather than the data products themselves. See also §5.

7.3 DM Leadership Team

The purpose of the DM Leadership Team (DMLT) 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 (Section 6.1) and DM Project Scientist (Section 6.3)
  - Lead Institution Technical/Control Account Managers (T/CAMs; Section 6.13.1)
  - Institutional Science or Engineering Leads (Section 6.13.2)
  - Members of the DM Systems Engineering Team (Section 7.2)
- 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 (DMCCB)

The DM Leadership Team and the DM System Engineering Team (Section 7.2) 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.

7.3.1 Communications

A mailing list[5] exists for DMLT related messages. On Mondays the DMLT hold a brief (30 to 45 minutes) telecon. This serves to:

- Allow the Project manager and DM Scientist to pass on important project level information and general guidance.
- Raise any blocking or poorly issues across DM — this may result in calling a splinter meeting to further discuss with relevant parties.
- Inform all team members of any change requests (LCRs) in process at LSST level which may be of interest to or have an impact on DM
- Check on outstanding actions on DMLT members

Face to Face meetings of DM are held twice a year these are opportunities to:

- Discuss detailed planning for the next cycle
- Discuss technical topics in a face to face environment
- Work together on critical issues
- Help make DM function as a team

7.4 DM Change Control Board

The DMCCB has responsibility for issues similar to those of the LSST Change Control Board, but with its scope restricted to the DM Subsystem. The DMCCB reviews and approves changes to all baselines in the Subsystem, including proposed changes to the DM System Requirements' (DMSR), reference design, sizing model, i.e. any LDM-series document. The DMCCB does not author the Technical Baseline and has no specific technical deliverables, 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

[5] lsst-dmlt@listserv.lsstcorp.org

for development of the Technical Baseline and evaluation of the content versus LSST and DM requirements are covered in DMTN-020.

- Charter/purpose
  - Ensure that the DM Technical Baseline (LDM-xxx) documents are baselined and subsequently changed only when necessary and according to LSST and DM configuration control processes
- Membership
  - Chaired by the System Engineer
  - Members include the DM Software Architect (§6.10), DM Operations Architect (§6.11), DM System Interfaces Scientist (§6.8), DM SQuaRE T/CAM (§6.13.1) and DM Project Manager (§6.1)
  - For on-line virtual meetings, if a consensus or quorum or 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.
  - Reviews and approves/rejects proposed changes to baselined items

8 Lead institutions in DM

8.1 LSST Tucson

The LSST Project Office in Tucson hosts the DM Project Manager (Section 6.1) and the Systems Engineer (Section 6.7). In addition, it is home to the Science Quality and Reliability Engineering (SQuaRE) group, described below.

8.1.1 Science Quality and Reliability Engineering

The SQuaRE group is primarily charged with providing technical feedback to the DM Project Manager that demonstrates that DM is fulfilling its responsibilities with regard to quality — of both scientific data products and software — software performance, and reliability. As such, areas of activity include:

- Development of algorithms to detect and analyse quality issues with data[6]
- 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
- DM documentation support, to include defining standards and providing tooling for documentation as well as some document writing
- 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 will bring them to the attention of the DM Software Architect. In the event that SQuaRE identifies issues with the quality of the data or algorithmic performance, it will bring them to the attention of the DM Project Scientist.

8.2 Princeton University

Princeton University hosts the Pipelines Scientist (Section 6.6) and the Data Release Production group, described below.

8.2.1 Data Release Production

The Data Release Production (DRP) group has three major areas of activity within DM.

- Definition and implementation of the scientific algorithms and pipelines which will be used to generated LSST's annual data releases;

[6] This may overlap with work carried out by the Science Pipelines groups (§§8.3.1 & 8.2.1). In some instances this will involve sharing code; in others, it may merit duplicating a metric to ensure that it is correct.

- Definition and implementation of the algorithms and pipelines which will be used to produce the “calibration products” (for example, flat fields, characterization of detector effects, etc) which will be used as inputs to the photometric calibration procedure in both nightly and annual data processing. This includes the development of the spectrophotometric data reduction pipeline for the Auxiliary Telescope;
- Development, in conjunction with the Alert Production team (AP; Section 8.3.1), of a library of re-usable software libraries and components which form the basis of both the AP and DRP pipelines and which are made available to science users within the LSST Science Platform.

Development of software in support of annual data releases and of reusable software components are carried out under the direction of the DRP Science Lead, who acts as product owner for this part of the system. The DRP Science Lead is ultimately responsible to both the Pipelines Scientist (Section 6.6) and DM Project Scientist (Section 6.3).

The product owner for calibration products product is the LSST Calibration Scientist (who doubles as the Pipelines Scientist, Section 6.6). The Calibration Scientist liases with other LSST subsystems and with the products owners of the annual and nightly data processing pipelines to ensure that appropriate calibration products are available to those pipelines to enable them to meet specifications.

Management of the group is the responsibility of the Science Pipelines T/CAM, reporting to the DM Project Manager (Section 6.1).

The DRP group is responsible for delivering software which adheres to the architectural and testing standard defined by the Software Architect (Section 6.10). In addition, the DRP group is responsible for testing each major product delivered to demonstrate its fitness for purpose, and working with the DM Project Scientist and DM System Science Team (Section 7.1) to define, run and analyze “data challenges” and other large scale tests to validate the performance of the data release production system.

8.3 The University of Washington

8.3.1 Alert Production

8.4 California Institute of Technology/IPAC

8.5 SLAC

SLAC hosts the DM Software Architect (Section 6.10) and the Science Data Archive and Data Access Services group described below.

8.5.1 Science Data Archive and Data Access Services

The Science Data Archive and Data Access Services (DAX) group has the following major areas of activity within DM:

- Provides software to support ingestion, indexing, query, and administration of DM catalog and image data products, data provenance, and other associated metadata within the LSST Data Access Centers;
- Provides implementations of data access services (including IVOA services), as well as associated client libraries, to be hosted within the LSST Data Access Centers, which facilitate interaction between LSST data products and tools provided by both other parts of the LSST project and by the astronomical research community at large;
- Provides a Python framework (the "Data Butler"), used by the LSST science pipelines, to facilitate abstract persistence/retrieval of in-memory Python objects to/from generic archives of those objects;
- Provides a Python framework ("SuperTask") which serves as an interface layer between pipeline orchestration and algorithmic code, and which allows pipelines to be constructed, configured, and run at the level of a single node or a group of tightly-synchronized nodes;
- Provides support for various middleware and infrastructure toolkits used by DM which would otherwise have no authoritative home institution within DM (e.g. logging support library, spherical geometry support library).

Management of the group is the responsibility of the DAX T/CAM, reporting to the DM Project Manager (Section 6.1).

The DAX group is responsible for delivering software which adheres to the architectural and testing standard defined by the Software Architect (Section 6.10). In addition, the DAX group is responsible for testing each major product delivered to demonstrate its fitness for purpose, and running and analyzing large scale tests to validate the performance of the science data archive and data access systems.

8.6 NCSA

9 Development Process

DM is essentially a large software project, more we are developing scientific software with the in uncertainties that brings with it. An agile [22] is particularly suited to scientific software development. The development follows a six month cyclical approach and DM products are under continuous integration using the application software Jenkins. All code is developed in the GitHub open source repository under an open source license. Releases follow a six month cadence but the master is intended to be always working with a continuous integration system ensuring this.

How this fits with the Earned Value System is described in DMTN-020.

9.1 Communications

The main stories for the six month planning period are discussed at the DMLT F2F meeting near the beginning of the cycle (See Section 7.3).

The T/CAMs of each of the institutions meet via video on Tuesdays and Fridays for a short *standup* meeting to ensure that any cross-team issues are surfaced and resolved expeditiously. This meeting is chaired by the Deputy Project Manager. Each T/CAM notes any significant progress of interest to other teams and any problems or potential problems that may arise.

9.2 Reviews

We expect DM level reviews from NSF/DOE. In addition internally we should review major components such as :

- Science and Alerts Pipelines Review
- QA Plan Review
- Science platform, perhaps in 3 parts
  - JupyterLab
  - SUI portal
  - Web/APIs
- Calibration Review

10 Data Management Problem/Conflict Resolution

The above organisational 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.

Any intra institutional problem should be bought as early as possible to the DM Project manager. The PM will attempt to mediate a resolution. The PM will consult with DMLT, DM System Science Team and DM System engineering if there are Scientific or technical impacts to be considered.

Should an issue need to be escalated the PM will bring it up in the weekly LSST project managers meeting. In that forum a way forward will be agreed with the LSST project manager and other sub system managers.

A DM Product List

WBS	Product	Description	Manager	Owner	Packages
.	Data Management	Data Management System			

.	Data Access Center	DAC Software			
	Bulk Distrib	Bulk Distribution System	Joel Plutchak		
	Proposal Manager	Proposal Manager	Joel Plutchak		
	Resource Manager	DAC Resource Manager	Joel Plutchak		
.	Data Backbone	Data Backbone System			
1.02C.06.02.01	Data Butler Client	Data Butler data access client library	Fritz Mueller		daf_persistence/ db/ daf_fmt_*
	Transport/Repl	File and database transport and replication with caching endpoints	Joel Plutchak		
.	Science Cat Archive	Science catalog archive			
1.02C.06.02.03	Qserv DBMS	Qserv distributed database system	Fritz Mueller		qserv/ partition/ scisql
.	Science Cat DBs	Science catalog databases			
1.02C.03.03	Alert DB	Alert database	Simon Krughoff	Eric Bellm	
1.02C.06.01.01	L1 Catalog DB	L1 catalog database	Fritz Mueller		cat
1.02C.06.01.01	L2 Catalog DB	L2 catalog database	Fritz Mueller		cat
.	Science Img Archive	Science image archive			
1.02C.06.02.05	Global Metadata	Global metadata service	Fritz Mueller		
1.02C.06.01.01	Provenance DB	Provenance database	Fritz Mueller		
.	Developer services	Developer services			
1.02C.10.02.03.01	Build/Unit Test	Build and unit test service	Frossie Economou		sconsUtils/ base/ lsstsw/ lsst_build
1.02C.10.02.03.04	Devel Comm Tools	Developer communication tools	Frossie Economou		
1.02C.10.02.03.03	Doc Infrastructure	Documentation infrastructure	Frossie Economou		lsst-texmf/ templates/ lsstDoxygen
1.02C.10.02.03.01	SW Version Control	Software version control system	Frossie Economou		
1.02C.10.02.03.05	Issue Tracking	Issue (ticket) tracking service	Frossie Economou		
1.02C.10.02.03.02	Packaging/Distrib	Packaging and distribution	Frossie Economou		lsst/ shebangtron/ lsst_dm_stack_demo
	Identity Manager	Identity (Authentication and Authorization) Manager	Joel Plutchak		
.	Infrastructure	Infrastructure Software Systems			
	Batch Proc	Batch Processing System	Joel Plutchak		
	Infra Systems	Filesystems/ provisioning/monitoring systems and system management	Joel Plutchak		
.	Task Execution	Task execution framework			
1.02C.06.03	Activator Bases	Activator base and Command Line Activator	Fritz Mueller		
1.02C.06.03	Pipeline Config	Pipeline configuration	Fritz Mueller		pex_config
1.02C.06.04.01	Logging	Logging	Fritz Mueller		log
1.02C.06.03	Multi-Core Task	Multi-core Task API	Fritz Mueller		
1.02C.06.03	Multi-Node Task	Multi-node Task API	Fritz Mueller		pipe_base/ ctrl_pool
1.02C.06.03	SuperTask	SuperTask	Fritz Mueller		pipe_supertask/ pipe_base/ pex_exceptions
	Integration Test	Integration and test			
1.02C.10.02.03.01	Contin Integration	Automated integration and test services	Frossie Economou		Jenkins
	Precursor Data	Precursor data for development and testing			obs_*/ validation_data_*/ testdata_*/ afwdata
.	IT Environments	Computing and Storage Infrastructure including provisioning			
.	Archive IT	Archive IT Environments			
	Archive Center Env	Archive Production Center environment	Joel Plutchak		
	Archive DAC Env	Archive DAC environment	Joel Plutchak		
	DAC Integ Env	DAC Integration environment (PDAC)	Joel Plutchak		
	Archive DBB Env	Archive Data Backbone endpoints and storage	Joel Plutchak		
	DBB Integ Env	Data Backbone Integration environment	Joel Plutchak		
	Dev Env	Developer environment	Joel Plutchak		
	L1 Integration Env	Level 1 Integration environment	Joel Plutchak		
	L2 Integration Env	Level 2 Integration environment	Joel Plutchak		
	Satellite Env	Satellite compute environment	Joel Plutchak		
	Science Valid Env	Archive science validation environment	Joel Plutchak		
.	Base IT	Base IT Environments			
	Base Center Env	Base Production Center environment	Joel Plutchak		
	Base DAC Env	Base DAC environment	Joel Plutchak		
	Base DBB Env	Base Data Backbone endpoints and storage	Joel Plutchak		
	Comm Cluster Env	Commissioning Cluster environment	Joel Plutchak		
.	Level 1 System	Level 1 System			
1.02C.03.03	Alert Distribution	Alert distribution service	Simon Krughoff	Eric Bellm	
1.02C.03.03	Alert Filtering	Alert filtering service	Simon Krughoff	Eric Bellm	
	L1 Offline Proc	L1 Offline Processing System	Joel Plutchak		

.	L1 OCS Components	Level 1 Online (OCS-connected) components			
	Archiver	Archiving Commandable SAL Component	Joel Plutchak	Felipe Menanteau	ctrl_iip
	Catchup Archiver	Catch-up Archiving Commandable SAL Component	Joel Plutchak	Felipe Menanteau	ctrl_iip
	EFD Tranform	EFD Transformation Commandable SAL Component	Joel Plutchak	Felipe Menanteau	
	Header Generator	Header Generator Commandable SAL Component	Joel Plutchak	Felipe Menanteau	
	OCS Batch Proc	OCS-Driven Batch Processing Commandable SAL Component	Joel Plutchak	Felipe Menanteau	ctrl_iip
	Pointing Publisher	Pointing Prediction Publishing Commandable SAL Component	Joel Plutchak	Felipe Menanteau	
	Prompt Proc	Prompt Processing Commandable SAL Component	Joel Plutchak	Felipe Menanteau	ctrl_iip
	Telem Gateway	Telemetry Gateway Commandable SAL Component	Joel Plutchak	Felipe Menanteau	ctrl_iip
.	L1 Science Payloads	L1 science payloads			
.	Offline Alert Prod	Offline Alert Production payload			
1.02C.03.03	Offline Alert Gen	Offline alert generation pipeline	Simon Krughoff	Eric Bellm	
1.02C.03.06	Moving Object	Moving object pipeline	Simon Krughoff	Eric Bellm	mops_daymops
1.02C.03.04	Precovery	Precovery and forced photometry pipeline	Simon Krughoff	Eric Bellm	
1.02C.03.01	Offline SFP	Offline single frame processing pipeline	Simon Krughoff	Eric Bellm	
.	Prompt Alert Prod	Prompt Processing Alert Production payload			
1.02C.03.03	Alert Gen Pipe	Alert generation pipeline	Simon Krughoff	Eric Bellm	
1.02C.03.01	Single Frame Pipe	Single frame processing pipeline	Simon Krughoff	Eric Bellm	pipe_drivers
1.02C.04.02	Aux Tel Spec Pipe	Offline Auxiliary Telescope spectrograph pipeline	John Swinbank	Jim Bosch	
1.02C.04.02	Daily Calibration	OCS-Controlled batch daily calibration update payload	John Swinbank	Jim Bosch	
1.02C.04.02	Offline Calibration	Offline calibration single frame processing pipeline	John Swinbank	Jim Bosch	pipe_drivers
1.02C.04.02	Prompt Calibration	Prompt Processing raw calibration validation payload	John Swinbank	Jim Bosch	pipe_drivers
1.02C.04.02	CBP Control	OCS control scripts for collimated beam projector control	John Swinbank	Jim Bosch	
	L1 Quality Control	L1 QC measurement generators	Simon Krughoff	Eric Bellm	
.	Level 1 Services	Level 1 Services			
.	Archiving Services	Image and EFD Archiving Services			
	Aux Tel Archiver	Auxiliary Telescope Archiving Service			
	ComCam Archiver	ComCam Archiving Service			
	LSSTCam Archiver	LSSTCam Archiving Service			
	ComCam Catchup	ComCam Catchup Archiving Service			
	LSSTCam Catchup	LSSTCam Catchup Archiving Service			
	EFD Transf Service	EFD Transformation Service			
	Pointing Service	Pointing Prediction Publishing Service			
.	Prompt Services	Prompt Processing Services			
	ComCam Prompt	ComCam Prompt Processing Service			
	LSSTCam Prompt	LSSTCam Prompt Processing Service			
.	Level 2 System	Level 2 System			
	L2 Quality Control	L2 QC measurement generators	John Swinbank	Jim Bosch	validate_drp/ verify_metrics/ ci_hsc
.	L2 Science Payloads	L2 science payloads			
1.02C.04.02	CPP Quality Control	CPP QC measurement generators	John Swinbank	Jim Bosch	
1.02C.04.02	Periodic Cal Prod	Periodic CPP payload	John Swinbank	Jim Bosch	
1.02C.04.02	Annual Cal Prod	Annual CPP payload	John Swinbank	Jim Bosch	
.	Data Release Prod	Annual mini-DRP and DRP payload			
1.02C.04.04	Coadd and Diff	Image coaddition and differencing	John Swinbank	Jim Bosch	pipe_drivers
1.02C.04.05	Coadd Processing	Coadd processing	John Swinbank	Jim Bosch	pipe_drivers
1.02C.04.06	DRP Postprocessing	DRP Postprocessing	John Swinbank	Jim Bosch	
1.02C.04.03	Image Char and Cal	Image characterization and calibration	John Swinbank	Jim Bosch	pipe_drivers
1.02C.04.06	Object Char	Multi-epoch object characterization	John Swinbank	Jim Bosch	
1.02C.04.05	Overlap Resolution	Overlap resolution	John Swinbank	Jim Bosch	
1.02C.06.01.01	DRP-Internal DB	DRP-internal database	Fritz Mueller		daf_ingest
1.02C.03.04	Template Gen Prod	Template generation payload	Simon Krughoff	Eric Bellm	
.	Production Exec	Production Execution System			
.	Campaign Manager	Campaign Manager	Joel Plutchak		

	Job Activator	Job Activator	Joel Plutchak		
	Pre-Flight Activator	Pre-flight Activator	Joel Plutchak		
	Workflow Manager	Workflow Manager/Orchestrator	Joel Plutchak		ctrl_orca/ ctrl_platform_*/ ctrl_execute/ ctrl_stats/ ctrl_provenance
	Workload Manager	Workload Manager	Joel Plutchak		
.	DM Networks	Data Management Provided Networks			
1.02C.07.04.06	Arc Extl Net	Archive External Network	Don Petravick	D Wheeler	
1.02C.07.04.03 (moving to 1.02C.08)	Base Network	Base Local Area Network	Don Petravick (moving to Jeff Kantor)	Jeff Kantor/Don Petravick	
.	Chilean Nat	Summit - Gatehouse La Serena - Gatehouse/ La Serena - Santiago Networks DWDM Equipment			
1.02C.08.03.01.03	Summit Net	Summit - AURA Gatehouse Network	Jeff Kantor	Jeff Kantor	
1.02C.08.03.01.04	DWDM Equipment	DWDM Equipment	Jeff Kantor	Jeff Kantor	
1.02C.08.03.01.01	La Serena Net	La Serena - AURA Gatehouse Network	Jeff Kantor	Jeff Kantor	
1.02C.08.03.01.01	La Ser - Santi	La Serena - Santiago Network	Jeff Kantor	Jeff Kantor	
.	Int/US WANs	International WAN/US WAN			
1.02C.08.03.02.01	Miami 100 Gbps	Santiago - Miami 100 Gbps Ring	Jeff Kantor	Jeff Kantor	
1.02C.08.03.02.02	Network Mgmt	Network Management	Jeff Kantor	Jeff Kantor	
1.02C.08.03.02.03	Santiago - Boca	Santiago - Boca Raton Spectrum	Jeff Kantor	Jeff Kantor	
1.02C.08.03.02.01	US National WAN	US National WAN	Jeff Kantor	Jeff Kantor	
1.02C.08.03	Long-Haul Nets	Summit - Base/ Base - Archive/ US Networks	Jeff Kantor	Jeff Kantor	
.	Science Algorithms	Common science algorithmic components			
1.02C.04.05	Aperture Corr	Aperture correction	John Swinbank	Jim Bosch	
1.02C.03.01	Artifact Detection	Artifact detection	Simon Krughoff	Eric Bellm	meas_algorithms
1.02C.03.01	Artifact Interp	Artifact interpolation	Simon Krughoff	Eric Bellm	
1.02C.04.05	Association/Match	Association and matching	John Swinbank	Jim Bosch	
1.02C.03.07	Astrometric Fit	Astrometric fitting	Simon Krughoff	Eric Bellm	jointcal/ meas_astrom/ meas_mosaic
1.02C.04.03	Background Estim	Background estimation	John Swinbank	Jim Bosch	meas_algorithms
1.02C.04.03	Background Ref	Background reference	John Swinbank	Jim Bosch	
1.02C.03.02	DIAObj Association	DIAObject association	Simon Krughoff	Eric Bellm	
1.02C.03.04	DCR Template Gen	DCR-corrected template generation	Simon Krughoff	Eric Bellm	
1.02C.04.05	Deblending	Deblending	John Swinbank	Jim Bosch	meas_deblender
	Img Decorrelation	Image decorrelation	Simon Krughoff	Eric Bellm	ip_diffim
1.02C.04.04	Image Coaddition	Image coaddition	John Swinbank	Jim Bosch	coadd_utils/ coadd_chisquared
1.02C.03.01	ISR	ISR	Simon Krughoff	Eric Bellm	pipe_tasks/ ip_isr
1.02C.04.05	Measurement	Measurement	John Swinbank	Jim Bosch	meas_base/ meas_algorithms/ meas_extensions_*/ meas_modelfit
.	Orbit/Ephemeris	Orbit tools			
1.02C.03.06	Attribution/Precov	Attribution and precovery	Simon Krughoff	Eric Bellm	mops_daymops
1.02C.03.06	Ephemeris Calc	Ephemeris calculation	Simon Krughoff	Eric Bellm	mops_night
1.02C.03.06	Orbit Fitting	Orbit fitting	Simon Krughoff	Eric Bellm	
1.02C.03.06	Orbit Merging	Orbit merging	Simon Krughoff	Eric Bellm	
1.02C.03.06	Tracklet Gen	Tracklet generation	Simon Krughoff	Eric Bellm	mops_daymops
1.02C.03.08	Photometric Fit	Photometric fitting	Simon Krughoff	Eric Bellm	jointcal/ meas_mosaic
	Proper Motion	Proper motion and parallax	Simon Krughoff	Eric Bellm	
1.02C.04.03	PSF Estim Large	PSF estimation (visit)	John Swinbank	Jim Bosch	
1.02C.03.01	PSF Estim Small	PSF estimation (1 CCD)	Simon Krughoff	Eric Bellm	meas_algorithms
1.02C.04.04	PSF Matching	PSF matching	John Swinbank	Jim Bosch	
	Raw Meas Cal	Raw measurement calibration	John Swinbank	Jim Bosch	
1.02C.03.01	Reference Catalogs	Reference catalogs	Simon Krughoff	Eric Bellm	meas_algorithms
1.02C.03.02	Reference Match	Matching to reference catalogs	Simon Krughoff	Eric Bellm	
1.02C.03.01	Spatial Models	Spatial models	Simon Krughoff	Eric Bellm	afw
1.02C.04.05	Source Detection	Source detection	John Swinbank	Jim Bosch	
1.02C.04.05	Star/Galaxy Sep	Star/galaxy classification	John Swinbank	Jim Bosch	
1.02C.03.04	Template Storage	Difference template storage/retrieval	Simon Krughoff	Eric Bellm	
	Variability Char	Variability characterization	Simon Krughoff	Eric Bellm	
.	Science Platform	Science Platform			
.	DAX VO+ Services	DAX VO+ services			
1.02C.06.02.05	Catalog Access	Catalog access	Fritz Mueller		dax_dbserv
1.02C.06.02.05	Cat Metadata Acc	Catalog metadata access	Fritz Mueller		dax_metaserv
1.02C.06.02.05	Img Metadata Acc	Image metadata access	Fritz Mueller		dax_metaserv
1.02C.06.02.04	Image Access	Image access	Fritz Mueller		dax_imgserv
1.02C.06.02.02	Web Framework	Web services framework	Fritz Mueller		dax_webserv/ dax_webservcommon

.	SciPlat JupyterLab	Science Platform JupyterLab component			
1.02C.10.02.02.05	JupyterLab Activator	JupyterLab Activators	Frossie Economou		
1.02C.10.02.02.06	JupyterLab Deploy	JupterHub deployment	Frossie Economou		
1.02C.10.02.02.01	JupyterLab Env	Basic JupyterLab environment	Frossie Economou		
1.02C.05.07.04	JupyterLab SUIT Intf	JupyterLab visualization widgets and other JupterHub/Portal bridges	Xiuqin Wu		
1.02C.10.02.02.04	JupyterLab SW Env	JupyterLab software environments	Frossie Economou		
.	SciPlat Portal	Science Platform portal component			
1.02C.05.07.03	Firefly Python APIs	Low-level Python API to Firefly	Xiuqin Wu		firefly_client
1.02C.05.06	Firefly	LSST-independent Firefly framework and visualization capabilities	Xiuqin Wu		firefly
1.02C.05.09	SUI Alert Interfaces	Portal alert interfaces to configure alert subscriptions	Xiuqin Wu		
1.02C.05.08	Portal Applications	Web application(s) implementing the Portal	Xiuqin Wu		
user workspace	Portal Interfaces	Interfaces to DAX	identity management	1.02C.05.07	Xiuqin Wu
1.02C.05.07.03	Visualizers	Firefly components to visualize LSST Science Pipelines data objects	Xiuqin Wu		
.	Science Primitives	Science software primitives			
1.02C.03.05	Camera Descr	Camera descriptions	Simon Krughoff	Eric Bellm	afw
1.02C.03.05	Chromaticity Utils	Chromaticity utilities	Simon Krughoff	Eric Bellm	afw
1.02C.04.01	Convolution	Convolution kernels	John Swinbank	Jim Bosch	afw
1.02C.03.05	Approx 2-D Fields	Interpolation and approximation of 2-D fields	Simon Krughoff	Eric Bellm	afw
1.02C.04.01	Footprints	Footprints	John Swinbank	Jim Bosch	afw
1.02C.03.05	Fourier Transforms	Fourier transforms	Simon Krughoff	Eric Bellm	afw
1.02C.03.05	Common Functions	Common functions and source profiles	Simon Krughoff	Eric Bellm	afw
.	Geometry	Geometry primitives			
1.02C.03.05	Cartesian Geom	Cartesian geometry	Simon Krughoff	Eric Bellm	
1.02C.03.05	Coord Transforms	Coordinate transformations	Simon Krughoff	Eric Bellm	afw/ astshim
1.02C.06.04.03	Spherical Geom	Spherical geometry	Fritz Mueller		sphgeom/ skypix/ skymap/ geom/ afw
1.02C.04.01	Images	Images	John Swinbank	Jim Bosch	afw
1.02C.04.01	MC Sampling	Monte Carlo sampling	John Swinbank	Jim Bosch	afw
1.02C.04.01	Num Integration	Numerical integration	John Swinbank	Jim Bosch	afw
1.02C.04.01	Num Optimization	Numerical optimization	John Swinbank	Jim Bosch	afw
1.02C.04.01	PhotoCal Repr	Photometric calibration representation	John Swinbank	Jim Bosch	afw
1.02C.06.02.01	Property/Metadata	Multi-type associative containers	Fritz Mueller		daf_base
1.02C.03.05	Point-Spread Funcs	Point-spread functions	Simon Krughoff	Eric Bellm	meas_algorithms/ shapelet
1.02C.04.01	Random Numbers	Random number generation	John Swinbank	Jim Bosch	afw
1.02C.04.01	Science Tools	Science tools	John Swinbank	Jim Bosch	afw/ utils
1.02C.04.01	Basic Statistics	Basic statistics	John Swinbank	Jim Bosch	afw
1.02C.04.01	Tables	Tables	John Swinbank	Jim Bosch	afw
1.02C.03.05	Tree Structures	Tree structures (for searching)	Simon Krughoff	Eric Bellm	afw
1.02C.04.01	Warping	Warping	John Swinbank	Jim Bosch	afw
.	QC Dashboard	QC measurement collection/storage/dashboard service			
1.02C.10.02.01.04	Alert QC	Alert stream QC harness	Frossie Economou		
1.02C.10.02.01.01	QC Harness	QC harness	Frossie Economou		validate_base
1.02C.10.02.01.02	QC Notifications	QC threshold notification framework	Frossie Economou		
1.02C.10.02.01.03	QC Reports	QC verification reporting	Frossie Economou		

B DM Discussion and Decision Making Process

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

B.1 Empowerment

All DM team members are empowered by the DM Project Manager (PM) and DM Subsystem Scientist (SS) 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.

B.2 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 Software Architect (SA), the DM Interface Scientist (IS), and the DM Subsystem Scientist (SS) 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 Slac Channel, 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.

B.3 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 Configuration Control Board (DMCCB) (Section 7.4) 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 DM 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.

B.4 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.

C References

[1] **[LSE-130]** *List of Data Items to be Exchanged Between the Camera and Data Management*, LSE-130, URL `https://ls.st/LSE-130`

[2] **[LSE-131]** *Data Management Interface Requirements to Support Education and Public Outreach*, LSE-131, URL `https://ls.st/LSE-131`

[3] **[LSE-140]** *Auxiliary Instrumentation Interface between Data Management and Telescope*, LSE-140, URL `https://ls.st/LSE-140`

[4] **[LSE-68]** *Data Acquisition Interface between Data Management and Camera*, LSE-68, URL `https://ls.st/LSE-68`

[5] **[LSE-69]** *Interface between the Camera and Data Management*, LSE-69, URL `https://ls.st/LSE-69`

[6] **[LSE-72]** *OCS Command Dictionary for Data Management*, LSE-72, URL `https://ls.st/LSE-72`

[7] **[LSE-75]** *Control System Interfaces between the Telescope and Data Management*, LSE-75, URL `https://ls.st/LSE-75`

[8] **[LSE-76]** *Infrastructure Interfaces between Summit Facility and Data Management*, LSE-76, URL `https://ls.st/LSE-76`

[9] **[LSE-77]** *Infrastructure Interfaces between Base Facility and Data Management*, LSE-77, URL `https://ls.st/LSE-77`

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[11] **[Document-9224]**, Angeli, G., McKercher, R., 2013, *Change Controlled Document Cover Page and Style Guide*, Document-9224, URL `https://ls.st/Document-9224`

[12] **[DMTN-020]**, Becla, J., Economou, F., Gelman, M., et al., 2016, *Project Management Guide*, DMTN-020, URL `https://dmtn-020.lsst.io/`

[13] **[LDM-472]**, Becla, J., Economou, F., Mueller, F., et al., 2017, *LSST DM Project Management and Tools*, LDM-472, URL `https://ls.st/LDM-472`

[14] **[LSE-29]**, Claver, C.F., The LSST Systems Engineering Integrated Project Team, 2016, *LSST System Requirements*, LSE-29, URL `https://ls.st/LSE-29`

[15] **[LSE-30]**, Claver, C.F., The LSST Systems Engineering Integrated Project Team, 2016, *LSST System Requirements*, LSE-30, URL `https://ls.st/LSE-30`

[16] **[LSE-61]**, Dubois-Felsmann, G., 2016, *LSST Data Management Subsystem Requirements*, LSE-61, URL `https://ls.st/LSE-61`

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

[18] **[LDM-151]**, Jurić, M., Lupton, R., et al., T.A., 2013, *Data Management Applications Design*, LDM-151, URL `https://ls.st/LDM-151`

[19] **[LSE-163]**, Juric, M., et al., 2017, *LSST Data Products Definition Document*, LSE-163, URL `https://ls.st/LSE-163`

[20] **[LDM-148]**, Kantor, J., Axelrod, T., 2013, *Data Management System Design*, LDM-148, URL `https://ls.st/LDM-148`

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

[22] Larman, C., Basili, V.R., 2003, Computer, 36, 47, doi:10.1109/MC.2003.1204375

[23] **[LPM-98]**, Long, K.E., 2016, *LSST Project Controls System Description*, LPM-98, URL `https://ls.st/LPM-98`

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[26] **[LPM-44]**, McKercher, R., 2016, *WBS Dictionary*, LPM-44, URL `https://ls.st/LPM-44`

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

[28] **[LDM-493]**, Sick, J., 2016, *Data Management Documentation Architecture*, LDM-493, URL `https://ls.st/LDM-493`

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D Acronyms

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

Acronym	Description
AP	Alerts Production
CAM	CAMera
CCB	Change Control Board
DAC	Data Access Centre
DM	Data Management
DMCCB	DM Change Control Board
DMIS	DM Interface Scientist

DMLT	DM Leadership Team
DMO	Data Management Organisation
DMS	Document Management System (ESA)
DMSR	DM System Requirements
DMSS	DM Subsystem Scientist
DOC	Department of Commerce (USA)
DRP	Data Release Production
ICD	Interface Control Document
LCR	LSST Change Request
LSE	LSST System Engineering (Document Handle)
LSST	Large-aperture Synoptic Survey Telescope
LaTeX	(Leslie) Lamport TeX (document markup language and document preparation system)
NCSA	National Center for Supercomputing Applications
NSF	National Science Foundation
OSS	Operations Support System
PDF	Portable Document Format
PM	Project Manager
PMCS	Project Management Control System
PS	Project Scientist
PST	Project Science Team
QA	Quality Assurance
RFC	Request for Comments
SAT	Science Archives Team (at ESAC)
SEMP	System Engineering Management Plan
SUIT	Science User Interface Team
TCAM	Technical Control/Account Manager
TCAMS	Technical Control/Account Manager
TCT	Technical Control Team (Obsolete - now DMCCB)
US	United States
WBS	Work Breakdown Structure