

Alternative science operations approach for Large Synoptic Survey Telescope (LSST)

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1 Introduction

We are currently experimenting with Google and Amazon services for science platform and processing. These services are priced to deliver compute and storage - our current model at the LSST Data Facility (LDF) is also service oriented but is not proceed in the same manner making comparisons difficult. It has been difficult to get an alternative cost model together. An initial approach to a cloud costing was outlined in DMTN-072, this approach was to try to cost the hardware and compare to cloud pricing.

In this document a radical restructuring of LSST operations is explored - a technology stack underpinned by commodity services which could be provided by commercial providers or computing centers. Here we look first at how we would run something like this -we can then leave one free variable which is the cost of the underlying compute and storage services. This will both help to sanity check the LDF costing and potentially allow us to have a ball park for assessing commodity provider offers.

2 Plugable service oriented architecture

In the Kavli workshop in Vegas (Feb 2019) we took a long term view to astronomy archives and data processing. We suggested a layered service model as depicted in Figure 1¹. Our requirements are no longer unique and we have access to a wealth of open source software, commodity hardware, and managed cloud services (offered by commercial providers and federally-funded institutions) that are well positioned to meet the needs of LSST Momcheva et al. (2019); Bektsev et al. (2019).

We took Figure 1 and made a more LSST oriented version in Figure 2. This is pretty close to how we are currently but we do not treat the compute and storage as pure services.

¹The full document is here <https://petabytestoscience.github.io/PetaBytes-2019-04-26.pdf>

Integrated Cyberinfrastructure

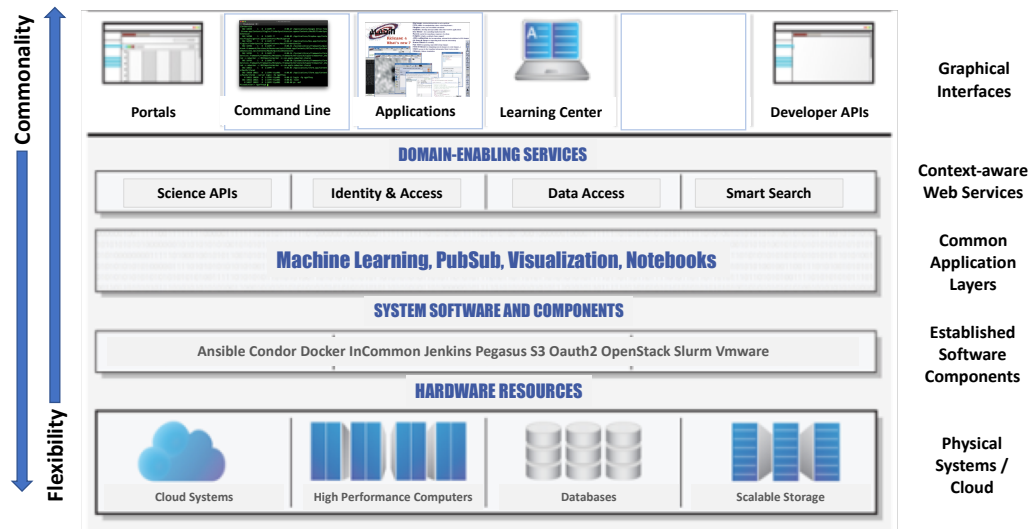


FIGURE 1: An example a cyberinfrastructure built on an Infrastructure as Code design model. Note that while this example does not have astronomy-specific tooling, our recommendations highlight the importance of developing astro-specific layers that are fully accessible to scientists in both the application and the graphical interface layers.

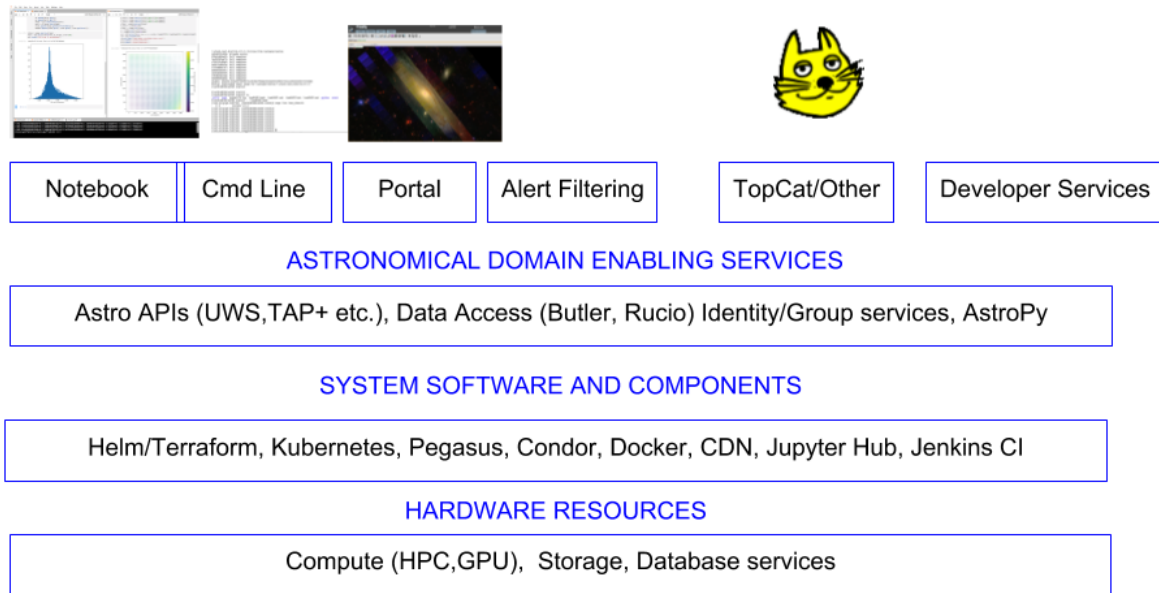


FIGURE 2: An example LSST cyberinfrastructure built analogous to the CI model shown in Figure 1.

3 Data Production Department

The role of data production within LSST is to deliver LSST’s science products: the science images, the alert stream, the annual data releases, the science software, and the Science Platform. In the current ops proposal not all groups required to do this are under control of Science operations.

Figure 4 gives a view of the Data Production teams which combine some of the old science operations and LDF departments. This is far more analogous to Data Management moving into operations than in the current proposal and would make for a smoother transition.

The Full Time Equivalent (FTE) counts are estimated in Table 1, which also gives the team sizes from the operations proposal for comparison. A brief description of the teams is given in Section 3.1.

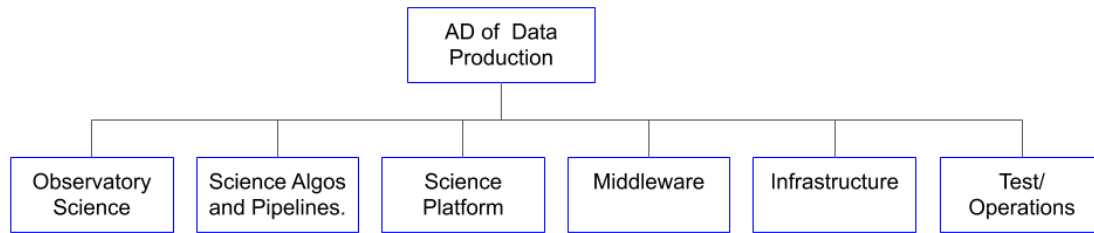


FIGURE 3: Possible configuration of Science Operations Department for operations of LSST

Table 1: Size of the various teams in data production department with size from the proposal in the fourth column - a zero implies the team did not exist in the proposal.

Team	FTE 2023	FTE 2026	Prop	Note
Management (Associate Director (AD))	1.5	1.5	1	
Observatory Science	5.5	5.5	5.5	System performance?
Science Platform	6	5	6	
Science Algos and Pipelines	22	16	16	QA to system performance?
Middleware	6.5	6.5	0	
Infrastructure	7	7	0	
Verification/ Operations	4	4	0	
LDF Management (AD)	0	0	3	In infrastructure
LDF Scientific Prod. Services	0	0	6.75	In Verification/ operations
LDF Information Technology Center (ITC) Security	0	0	8.5	Some in infrastructure/ middleware
LDF Production Services	0	0	4.3	Some in infrastructure
LDF ITC and Facilities	0	0	12.25	Should be in services charges
Total	52.5	45.5	63.3	

3.1 Teams

Figure 3 introduces several teams some of which were not in the original ops proposal. Little detail is given here about each.

3.1.1 Observatory Science

As in the ops proposal the primary responsibility of this team is to understand the end-to-end impact of the Observatory hardware and environment on the science images and to work with the Observatory Operations department to ensure that the image quality meets requirements.

This team may be better in Observatory operations department

3.1.2 Science algorithms and pipelines

This team is responsible to assess and assure the alert stream and annual data releases. In the submitted proposal this includes extensive Quality Assurance (QA) to compare the data products against requirements - this may be better merged with System Performance/Verification. The main responsibility of this team would then be the underlying software pipelines themselves. Monitoring and updating the calibration plan and algorithmic implementation is also a responsibility of this team. The Calibration Support Scientist on the Observatory Science team will be responsible for monitoring the physical implementation of the calibration plan at the summit. In Table 1 this team is initially sized similarly to the AP/DRP teams in construction. There will be significant maintenance in the first two or three years of operations. As mentioned above there may be some consolidation with QA activities in System Performance.

3.1.3 Science platform

This team will be responsible for maintaining and evolving LSST's user access portal, the Science Platform. This will include keeping up with evolving technologies and computing infrastructure, as well as providing basic code-base maintenance, bug fixes, and low-level response to science community and internal LSST requests for new features.

3.1.4 Middleware

In a service oriented model with a layered architecture as outlined in Section 2 it is essential to have a cross cutting team who compose and debug services. Software such as the butler is not part of the pipeline but the pipeline needs it. In house developments such as Qserv should be covered here (1.5FTE has been included for this - DOE/SLAC personnel - could be 2). This would also cover the builds and how the code interacts with the infrastructure (Section ??).

3.1.5 Infrastructure, Site Reliability Engineering

This is for deployment of various systems and pipelines. Configuration is included in this. There needs to be a couple of people who manage keys/secrets for access to commodity services. We would need a security resource as well as database expertise. This then implies using tooling for system management as provided by e.g. Amazon Web Services, one of the largest cloud computing providers. (AWS) console.

In general an Site Reliability Engineering (SRE) team is responsible for the availability, latency, performance, efficiency, change management, monitoring, emergency response and capacity planning of their services Beyer et al. (2016).

This team would include paying for a liaison at any service provider e.g. Google Professional Services or a Service Manager at National Center for Supercomputing Applications (NCSA). (2FTE calculated)

3.1.6 Verification/Operations

This team will take and verify new releases for operations before they are deployed to the operations system. They will monitor the operational system to make sure it is functioning - they should have some science knowledge to know it is actually working properly as opposed to not just giving errors. A team of 4 should be able to handle this. Some support for this is assumed from IN2P3 .

4 Other implied changes to the current operations proposal

Notably missing from Figure 3 is QA. Currently QA is spread across three departments - the suggestion here is to place all QA activities under the survey performance department. Consolidation of the QA activities in one department may allow for some personnel saving.

The data release team in science operations would require a verification scientist (this may be 0.5FTE) while the Science Data Quality Assurance (SDQA) and Semantic scientists may move to QA in survey science.

All data facility work, be it with a partner or in commercial cloud should be firmly under science operations - hence there is no LDF department and no associate director for LDF as depicted in Figure 4.²

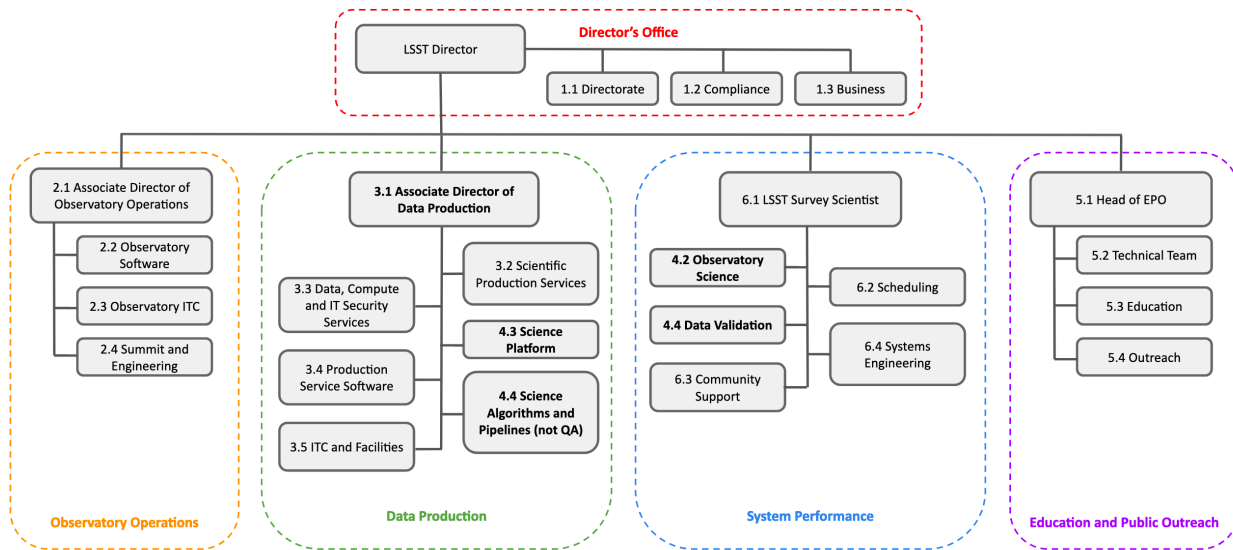


FIGURE 4: Possible new organisation chart for LSST operations

NOTE: I have said before communications should report directly to the director - in Figure 4 there is NO communications.

ITC and facilities (Figure 4) in this model should come from National Center for Optical-Infrared Astronomy (NCOA) logically also this does not belong in data production but at a higher level its for the entire org, the observatory already has its own ITC group so they are good.

²This is in line with AMCL recommendations

There are still some developments in NCSA such as Data Acquisition System (DAQ) forwarders which would need to be included in possibly the observatory software.

There are other developments Data Back Bone (DBB) which could be replaced by commodity services like Amazon S3 which includes replications and reliability.

5 Conclusion

A restructuring of operations would give more transparent cost, allow for a better comparison to commodity pricing for many services and would yield considerable savings.

A References

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LSST Data Management Technical Note

B Glossary

AD Associate Director.

AWS Amazon Web Services, one of the largest cloud computing providers..

CI cyberinfrastructure.

cloud A visible mass of condensed water vapor floating in the atmosphere, typically high above the ground or in interstellar space acting as the birthplace for stars. Also a way of computing (on other peoples computers leveraging their services and availability)..

cyberinfrastructure Sometimes denoted CI, A term first used by the United States (US) National Science Foundation (National Science Foundation (NSF)), and it typically is used to refer to information technology systems that provide particularly powerful and advanced capabilities..

DAQ Data Acquisition System.

DBB Data Back Bone.

FTE Full Time Equivalent.

ITC Information Technology Center.

LDF LSST Data Facility.

LSST Large Synoptic Survey Telescope.

NCOA National Center for Optical-Infrared Astronomy.

NCSA National Center for Supercomputing Applications.

NSF National Science Foundation.

QA Quality Assurance.

Qserv Proprietary LSST Database system.

S3 Structured, imperative high level computer programming language, used as implementation language for the Virtual Machine Environment (Virtual Machine Environment (VME)) operating system.

SDQA Science Data Quality Assurance.

software The programs and other operating information used by a computer..

SRE Site Reliability Engineering.

US United States.

VME Virtual Machine Environment.