LSST
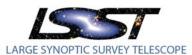## LARGE SYNOPTIC SURVEY TELESCOPE

Memorandum of Agreement
between
The Board of Trustees of the University of Illinois (on behalf of the National Center for Supercomputing Applications-NCSA) and
the Association of Universities for Research in Astronomy (AURA)

Document-4245

Latest Revision 17 April 2012

MEMORANDUM OF AGREEMENT BETWEEN THE BOARD OF TRUSTEES OF THE UNIVERSITY OF ILLINOIS AND THE ASSOCIATION OF UNIVERSITIES FOR RESEARCH IN ASTRONOMY.

THIS MEMORANDUM OF AGREEMENT (hereinafter referred to as the MoA), made and entered into between the Board of Trustees of the University of Illinois, doing business on its Urbana-Champaign campus, on behalf of the National Center for Supercomputing Applications-NCSA through the Office of Sponsored Programs and Research Administration located at 1901 S. First Street, Suite A, Champaign, Illinois 61820 (hereinafter referred to as the University) and the Association of Universities for Research in Astronomy on behalf of the Large Synoptic Survey Telescope Project Office, whose principal office is located at 933 N. Cherry Avenue, Tucson, Arizona 85721, (hereinafter referred to as the LPO). The parties may be referred to individually as "Party" or collectively as the 'Parties"

Preamble

WHEREAS the Large Synoptic Survey Telescope Project (LSST) is being developed in order to advance the science of astronomy and physics, and

WHEREAS LSST is a public-private collaboration of scientists, engineers, national laboratories and organizations, and

WHEREAS LSST Corporation (LSSTC), is a non-profit corporation established to manage this public-private collaboration and to raise private and agency funding to support LSST, and

WHEREAS the LPO is a Center of the Association of Universities for Research in Astronomy, Inc. (AURA) established for the purpose of managing all LSST construction activity funded by the National Science Foundation to support LSST, and
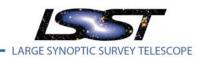
WHEREAS the University has a National Supercomputing Laboratory with fundamental interests in the scientific and technical mission of the LSST, and

WHEREAS the University has a unique technical capability to design, develop, and operate the LSST Archive Site.

THE PARTIES UNDERSTAND AND AGREE AS FOLLOWS:

Article 1 – Purpose

The Parties desire to form a cooperative relationship to design, build and commission the LSST Observatory.   This agreement establishes the Terms and Conditions of the cooperative relationship between the Parties that will assure successful integration of the overall mission and performance of the LSST Observatory.

Subject to funding provided by the National Science Foundation (NSF) and private sources to LSST Corporation, LPO will undertake the design, construction, and commissioning of all components of the LSST Observatory except for the camera; this includes but is not limited to the telescope, site facilities, data management, education and public outreach (EPO), and data access centers. Subject to funding provided by the Department of Energy (DOE) to LSST Corporation, SLAC National Accelerator Laboratory (SLAC) will undertake the design, construction, and delivery of the LSST camera. DOE and NSF have established a Joint Oversight Group (JOG), which will coordinate the interaction between the two federal agencies.
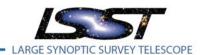
The cooperative relationship established by this MoA will enable LPO and the University to work together to complete the Data Management work package.

LPO will designate the University as the lead institution for the Archive Site and associated processing sites for the project. The University, in the role of lead archival data center for the project, will perform the construction and commissioning work associated with Work Breakdown Structure 02C.07 Computing Storage and Archive Site (see Attachment A NCSA Construction/Commissioning Work Breakdown Structure), in accordance with LSST project policies, procedures, and standards which will be provided to NCSA. This work includes:

- Acquire or develop, integrate, test, and document software for data management system administration, control, and security;
- Acquire or develop, integrate, test, and document software for data transfer and distributed file management;
- Acquire or develop, integrate, test, and document software for system monitoring, software engineering, software build/deployment, distributed pipeline execution, pipeline control and monitoring;
- Specify, acquire, configure, test, and deploy computing, storage and network infrastructure for the Archive Site;
- Operate the above elements at the Archive Site on behalf of the data management team during construction and commissioning;
- Specify, acquire, configure, test, and ship computing, storage and network infrastructure for the Base Site.
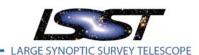
Article 2 – Conditions for participation

1. The LSST Data Management (DM) Project Manager and Project Scientist will be selected by the LPO Project Manager and Project Director. Both Parties will recognize that the LSST DM Project Manager and Project Scientist are the lead personnel responsible for Data Management system level decisions. This team will select a DM System Architect, who will help to guide the DM project.
2. The DM Project Manager and Systems Architect will be responsible for establishing and maintaining high-level, coordinating schedule Milestones that may only be approved or

changed with the approval of the DM Project Management Council (PMC). Both Parties will participate in the DM PMC and comply with its decisions.

3. The Systems Architect will be responsible for establishing and maintaining DM system-level Interface Control Documents (ICD's) that cross the boundary between the Parties. The ICD's may only be approved or changed in accordance with the DM Systems Architecture Team (SAT). Both Parties will participate in the SAT and comply with its decisions.

4. The DM system will be designed and developed under configuration control and documented standards as defined by the DM Technical Control Team (TCT).Both Parties will participate in the TCT and comply with its decisions.

5. The DM system will be designed to comply with the LSST Observatory System Specifications (OSS) which flow down the LSST science requirements from the LSST Science Requirements Document (SRD). Flow-down of these scientific requirements to the DM system is the responsibility of the DM Project Scientist and System Architect, advised by the DM Science Steering Team (SST). Both Parties will comply with the decisions of the DM Project Scientist and System Architect.

6. Both Parties will contribute to the monthly DM report, which is integrated into the LSSTC Board of Directors Technical Progress Report. The University will provide sufficiently detailed monthly progress reports to create Earned Value Management System Reports in the LSST Project Management Control System.

7. Both Parties will store all project documents in the LSST document archive.

8. Both Parties will participate jointly in regularly scheduled LSST and DM Project Management Meetings.

9. Both Parties will inform and allow the LSST Director, Deputy Director, Project Manager, System Engineer, DM Project Manager, DM Project Scientist, and DM System Architect to attend all significant technical and management meetings.

Article 3 – Personnel

1. Each Party will select and supervise its own personnel. University employees shall not work on LSST without the express knowledge of the DM Project Manager.

2. Each Party will manage its personnel pursuant to any applicable legislation and internal policies.

3. The status of personnel will not change as a consequence of participation in the project governed by this MoA.

4. The University will be responsible for annual performance reviews and compensation adjustments of its employees in accordance with University policies and procedures. To the extent reviews contain an evaluation of performance related to LSST activities, the LSST DM Project Manager will have the opportunity to acknowledge and provide comment to the University on LSST related activities.

5. The University shall assign a full-time Project Manager for all LSST activities undertaken by the University. The University Project Manager will inform the LSST Project Manager of all work assignment and personnel changes. The LSST DM Project Manager will have key input on the annual performance review of the Project Manager's performance related to LSST activities, jointly with the University Project Manager's supervisor within the University.

6. The University shall establish a "core team" of personnel who work on LSST full-time. We estimate this core team shall be staffed to cover at least 50% of the University's LSST labor budget, but the full determination of this should be determined by discussions with the Project Manager and the LSST DM Project Manager.

7. On an as-needed basis, the University Project Manager may request that other University employees work on LSST activities either full-time or part-time. Unless unduly disruptive of other University activities, such requests shall be given high priority by the responsible University manager. For their LSST assignments, these University employees shall receive direction from the University Project Manager.

Article 4 – Publication

Any publication resulting partly or totally from the work carried out in the framework of this MoA shall be handled in accordance with each author's institutional publication policies and also by the terms and conditions of the LSST Publication Policy as approved by the LSSTC Board of Directors and is incorporated by reference to this MoA as Attachment B. If there is a conflict in the author's institutional publication policies and the LSST Publication policy, the author's institutional policy will govern.

The authors of publications shall remain subject to the rules of their respective employer.

Article 5 –Intellectual property

5-1 Definition

Intellectual property is property protected under intellectual property law by patent rights, copyrights, and similar rights. Intellectual property includes but is not limited to inventions, technical data, and software as well as applications for protection of the same.

5-2 Generation of intellectual property

Intellectual property created exclusively by one Party shall be the exclusive intellectual property of that Party. Intellectual property created jointly by the Parties shall be the joint intellectual property of both Parties.

The National Science Foundation (NSF) and the University have such rights in the intellectual property developed with University resources by the Parties to this MoA as are set out in the LSST – University Subaward No. C44006L, effective 9/1/05 and last amended on 10/1/11. At a

minimum, NSF has a world-wide royalty-free paid up right to use any intellectual property which is generated with University resources under this MoA.

Rights with regard to commercialization of exclusively developed or created intellectual property are retained by the Party that developed or created that intellectual property. Commercialization of intellectual property jointly developed or created by the Parties shall be jointly pursued. In the event of a conflict in rights, the University and LPO will attempt to negotiate a resolution satisfactory to themselves and their sponsoring agencies before resorting to alternate forms of resolution.

5-3 Sharing of pre-existing intellectual property

Each Party shall license royalty-free to the other Party its pre-existing intellectual property as required for the performance of work under this MoA, always ensuring that such license is compatible with the existing obligations of the licensing Party.
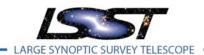
Pre-existing intellectual property provided by a Party to the other Party shall not create any right in that intellectual property for the receiving Party.

The Parties do not provide any express or implied warranties of any kind concerning their intellectual property utilized under this MoA, and the Parties do not accept any liability with regard thereto.

Article 6- Confidentiality

Each Party agrees to keep confidential any information, document or other material which is communicated to it as confidential by the disclosing Party. Confidential information must be clearly marked as confidential prior to transmission to the other Party, or in case of an oral disclosure, reduced to writing and marked "confidential" by the disclosing Party within thirty days of disclosure, with a copy sent to the receiving Party. Each Party shall limit the circle of recipients of confidential information to its employees on a need-to-know basis and shall ensure that the recipients are aware and comply with the obligations defined in this confidentiality clause.

Notwithstanding the above, a Party is entitled to disclose confidential information which it is required by law, court order or Illinois Freedom of Information Act to disclose or which, in a lawful manner, it has obtained from a third party without any obligation of confidentiality, or which it has developed independently of confidential information, or which has become public knowledge in a way other than as a result of a breach by that Party of its obligations under this confidentiality clause or which has been explicitly approve release by written authorization of the disclosing Party.

Article 7 – Termination of the MoA

This MoA may be terminated at any time by either Party, after consultation with the Joint Oversight Group (JOG). The Party terminating will give 90 days written notice to the other Party.

Surviving such termination are:

a. The responsibility of each Party for its share of the costs incurred through the effective date of termination, as well as its share of the costs incurred after the effective date of termination and which are related to the MoA;

b. The Intellectual Property use rights as defined in articles 5.2 and 5.3 and confidentiality obligations as defined in article 6, if any, of this MoA; and

c. Contractual obligations established in an addendum for specific work, but surviving only in accordance with the termination terms and conditions of that addendum.

Article 8 – Entry into force and Duration

This MoA shall enter into force on the date of the last signature by the Parties.

Unless otherwise terminated, the MoA shall remain effective until the LSST Observatory begins full science operations at the end of commissioning.

Article 9 - Amendments/Annexes

This MoA may be modified or amended as deemed necessary by written agreement signed by authorized representatives of both Parties.

All Annexes and amendments to this MoA form an integral part of it.

Article 10 - Settlement of disputes

In the event of any dispute or difference arising out of the interpretation or implementation or application of the provisions of this MoA, the Parties shall settle it amicably through consultation or negotiation that may result in appropriate amendments to this MoA.

If no amicable agreement is reached within a period of thirty (30) days, either party may take the disagreement to the JOG of the sponsoring agencies in a good faith attempt to resolve the dispute. Resolution of the dispute will be reduced to writing in an amendment and signed by authorized representatives of both parties.
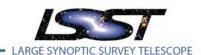
In all steps of the resolution process, the settlement of the dispute shall be based on this MoA (as amended) and on equity.

Article 11 – Counterparts

This MoA may be executed in any number of counterparts, including facsimile or scanned PDF documents. Each such counterpart, facsimile or scanned PDF document shall be deemed an original instrument, and all of which together, shall constitute one and the same executed MoA.

This Memorandum of Agreement is provided in two (2) original copies, one for each Signatory.

IN WITNESS WHEREOF, the University and LPO have executed this memorandum of agreement this _____ day of _____ 2012.

THE BOARD OF TRUSTEES OF THE   ASSOCIATION OF UNIVERSITIES
UNIVERSITY OF ILLINOIS   FOR REASEARCH IN ASTRONOMY

_____   _____
Walter K. Knorr, Comptroller   William S. Smith
                                                                             AURA President

_____   _____
Dr. Thomas H. Dunning, Jr.   Sidney C. Wolff
Director, NCSA   President LSSTC

_____   _____
Danny Powell,   David MacFarlane
Executive Director, NCSA   Chairman, LSSTC Board

Attachment A: NCSA Construction/Commissioning Work Breakdown Structure
Attachment B: LSST Publication Policy LPM-53, incorporated by reference

Attachment A: NCSA Construction/Commissioning Work Breakdown Structure

02C.07 Processing Control and Site Infrastructure

This WBS element is a summary element that includes all infrastructure acquisition, configuration, test, and where required packaging and shipping for the Archive and Base Sites. It also includes the acquisition, configuration, deployment, and administration of all development tools and environments, including both development and integration clusters. Finally, it includes software programs, database tables, configuration files, unit tests, component integration tests, and documentation.

This WBS element implements the following UML design elements:
- DMS Control and Management
- Communications
- File System Services
- DMS Security

These services provide the ability to execute DMS processing on distributed, heterogeneous computing and communications platforms, in parallel clustered and grid configurations. All services will be implemented to provide reasonable fault-tolerance and autonomous recovery in the event software and hardware failures

02C.07.01 Processing Control

This WBS element is a summary element that includes software programs, database tables, configuration files, unit tests, component integration tests, and documentation that implements the Processing Middleware capabilities.

This WBS element implements the following UML design elements:
- Control and Management Services (including communications)

These services provide the ability to execute DMS processing on distributed, heterogeneous computing and communications platforms, in parallel clustered and grid configurations. All services will be implemented to provide reasonable fault-tolerance and autonomous recovery in the event software and hardware failures

02C.07.01.01 Data Management Control System

This WBS element includes software programs, database tables, configuration files, unit tests, and documentation that implement the Data Management Control System (DMCS).

The DMCS at each site is responsible for initializing and running diagnostics on all equipment, including computing nodes, disk storage, tape storage, and networking. It establishes and

maintains connectivity with the other sites including the Headquarters Site. It monitors the operation of all hardware and software.

At the Base Center, the DMCS is responsible for interfacing with the Observatory Control System (OCS). At the Archive Center, the DMCS performs resource management for the compute cluster and initializes replication services. At each Data Access Center, the DMCS performs resource management for the Level 3 Data Products compute cluster and initializes replication services.

This WBS element implements the following UML use cases:
Archive Center DMCS
- Execute Alert Production Reprocessing at Archive
- Execute Data Release Processing
- Process Calibrations
- Process Observations
- Register in VO
- Replicate to Data Access Centers
- Retire Previous Data Release
- Initialize Archive Center
- Monitor Archive Center
- Reconfigure Hardware
- Shut Down
Base Center DMCS
- Change to Calibration Mode
- Change to Day Mode
- Change to Maintenance Mode
- Change to Observing Mode
- Initialize Base Center
- Monitor Base Center
- Reconfigure Hardware
- Shut Down
Data Access Center DMCS
- Initialize Data Access Center System
- Monitor Data Access Center
- Reconfigure Hardware
- Shut Down

02C.07.01.02 Orchestration Manager

This WBS element includes software programs, database tables, configuration files, unit tests, and documentation that implement orchestration services.
Orchestration services are responsible for deploying pipelines and Policies onto nodes, ensuring that their input data is staged appropriately, distributing dataset identifiers to be processed, recording provenance, and starting pipeline execution.

This WBS element implements the following UML use cases:
Orchestration
- Deploy and Execute Pipeline
- Manage Pipeline Execution
- Terminate Pipeline Execution
Pipeline Control
- Define Execution Environment
- Configure Access to Data
- Configure Pipeline
- Stop Pipeline Execution
- Cleanup after Execution
- Record Pipeline Execution Status
- Monitor Pipeline Execution
- Pipeline Execution

02C.07.02 Infrastructure Services

This WBS element is a summary element that includes software programs, database tables, configuration files, unit tests, component integration tests, and documentation that implements the Infrastructure Services capabilities.
Infrastructure Services provide portable, integrated access to fundamental operating system, network, and graphics capabilities via software interfaces and tools.

This WBS element implements the following UML design elements:
- Event Services
- Security and Access Control Services
- User Interface/Visualization Services
- System Administration and Operations Services
- File System Services

02C.07.02.01 Event Services

This WBS element includes software programs, database tables, configuration files, unit tests, and documentation that implement event notification services.
Event services are used to communicate among components of the DM System, including between pipelines in a production.

This WBS element implements the following UML use cases:
Event System
- Configure Event Logging
- Register Event Receiver
- Register Event Transmitter
- Publish Event Using Event System

- Retrieve Event Using Event System
Event Monitoring
- Initialize Event Monitor
- Process Incoming Event
- Publish Event Using Event System

02C.07.02.02 Security and Access Control Services

This WBS element includes software programs, database tables, configuration files, unit tests, and documentation.

This WBS element implements the following UML design elements:
- Authorization/Authentication
- Access Control (Enforcement)

This WBS element implements the following UML use cases:
- Administer Certificates
- Administer Groups and Users
- Configure Security Profiles and Policies
- Enforce Security Policies

02C.07.02.03 User Interface/Visualization Services

This WBS element includes software programs, configuration files, unit tests, component integration tests, and documentation.

This WBS element implements the following UML design elements:
- Create and configure displays and plots of static data and metadata in graphical and tabular forms
- Create and configure static and continuously updating displays of real-time data streams in graphical and tabular forms

This WBS element implements the following UML use cases:
- Dynamic Display of Data and Metsdata
- Static Display of Data and Metadata

02C.07.02.04 System Administration and Operations Services

This WBS element includes software programs, configuration files, unit tests, component integration tests, and documentation that implement the System Administration and Operations capabilities.
System Administration and Operations Services is composed of low-level tools that monitor systems and provide information on current status.

This WBS element implements the following UML design elements:
- Provide an interface to formatted data describing the current operational state of the LSST DMS, including equipment health and workload, pipeline processing status, data query and ingest workload, data transfer workload, and DMS performance snapshots and trends.
- Provide an interface to formatted data describing the internal state of LSST data archives and catalogs, including data integrity, usage patterns, and logical and physical schemas
- Provide an interface to formatted data describing configuration of the LSST DMS subsystem.

02C.07.02.05 File System Services

This WBS element includes software programs, database tables, configuration files, unit tests, component integration tests, and documentation that implement distributed File System Services. File System Services provides file-based access over local storage, local area networks, and wide area networks.
This WBS element also includes off-the-shelf distributed file system capabilities, e.g. iRODS, Lustre, gpfs.

This WBS element implements the following UML use cases:
- Access file-based data (local and remote)
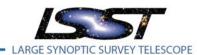- Define file access for groups
- Define file access for users

02C.07.03 Environment and Tools

This WBS element is a summary element that includes tools and data needed in the development, integration and test, and support of the DM systems and software.

02C.07.03.01 Software Development Tools

This WBS element includes off-the-shelf tools for DMS software development, including:
- Compilers
- Interpreters
- Linkers
- Make Utilities
- Editors
- Debuggers
- Test Generators
- CASE Tools
- Version Control System
- Document Generators
- Profilers

02C.07.03.02 Camera/DAQ Test Bed

This WBS element contains a test environment that includes the Camera/DAQ interfaces and a raw science image simulated data stream generator. It is provided by the Camera team under a Camera WBS element and configured for DM use under this element.

02C.07.03.03 Telescope/OCS Interfaces Test Bed

This WBS element contains a test environment that includes the integrated control system interfaces, and simulated TCS/OCS command and status data streams generator. It is provided by the Telescope and Site team under a T&S WBS element and configured for DM use under this element.

02C.07.03.04 Pre-Cursor and Simulated Data Server

This WBS element contains a data repository containing multiple terabytes of pre-cursor (e.g. SM/Essence, MACHO, DLS, DEC, Pan-STARRS, CFHTLS, TALCS, Subaru) and LSST simulated data for algorithm and scaling tests.

02C.07.03.05 Virtual Observatory Repository Server

This WBS element includes a complete implementation of all basic VO Repository services and protocols to be used as a test environment for VO interfaces.
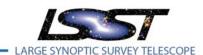
02C.07.03.06 Test Data

This WBS element includes simulated or subset LSST data products of all types for use in DMS testing. It is derived from the Pre-Cursor and Simulated Data Server and is oriented at providing data to pipelines and productions during testing.

02C.07.03.07 Test Harnesses and Scripts

This WBS element includes subsystem and system integration and test harnesses and scripts that exercise the DMS in all end-to-end usage scenarios.
- The Subsystem Integration Test Harnesses and Scripts simulate the behavior and data stream of each DMS component. They implement the Test Cases created in the Data Management Subsystem Integration and Test element.
- The System Integration Test Harnesses and Scripts simulate the other LSST subsystem and end user behavior and data streams (including driving test harnesses in the System Integration and Test element.

02C.07.03.08 Operational Control and Monitoring System

This WBS element contains end user tools that allow management and monitoring of all Data Management System operational status, including: system health and welfare, pipeline/production execution status, data transfer status, operational modes and schedules. This WBS is also known as the Data Management Systems Operations Center.

This WBS element contains hardware and end-user display tools to monitor the LSST DMS subsystem.

02C.07.04 Site Infrastructure

This WBS element is a summary element that includes all infrastructure acquisition, configuration, test, and where required packaging and shipping for the Archive and Base Sites. It also includes the acquisition, configuration, deployment, and administration of all development tools and environments, including both development and integration clusters.

02C.07.04.01 Archive Center Infrastructure

This WBS element includes the acquisition, configuration, test, and operation of infrastructure for the Archive Center.

02C.07.04.01.01 Data Acquisition Equipment

This WBS element includes a copy of the Mountain/Base DAQ equipment used for interface testing. It is provided by the Camera Subsystem.

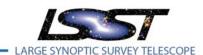02C.07.04.01.02 Computing Servers

This WBS element includes the compute servers (including cluster infrastructure and fileservers for pipeline disk cache) that host the pipelines that produce Data Release data products as well as all servers need to operate the Archive Center. This will be sized for re-processing the entire survey each year.

02C.07.04.01.03 Workstations

This WBS element includes computers used primarily by on-site personnel to operate and maintain the archive and pipelines.

02C.07.04.01.04 High Speed Pipeline Disk Cache

This WBS element includes disks, controllers, and storage network connected directly to pipeline servers for processing data. These resources are sized and selected for the highest required data input/output rates.

02C.07.04.01.05 Near-Line Archive Storage

This WBS element includes high-speed disk, controllers, storage network, and fileservers used to support Archive Center operations and serve as a secondary disk cache for the pipeline servers.

02C.07.04.01.06 Deep Storage

This WBS element includes slower-speed disk, tape libraries, controllers, storage network and storage servers that provide long-term storage for all LSST archived data.

02C.07.04.01.07 Archive Center Networks

This WBS element includes network switches, routers, cables, interfaces connecting servers, workstations, storage and communications within the Archive Center.

02C.07.04.02 US Data Access Center Infrastructure

This WBS element includes the acquisition, configuration, test, and operation of infrastructure of the US DAC.

02C.07.04.02.01 Data Access Servers

This WBS element includes servers that carry out the operation and management of the Data Access Center including inter-site data replication and query services, but excluding fileservers/storage management.

02C.07.04.02.02 High Speed Primary Storage

This WBS element includes high-speed disk, controllers, storage network, and fileservers used to support Data Access Center operations. The design is scaled-down version of the Archive Center Near-line Archive Storage.

02C.07.04.03 Base Center Infrastructure

This WBS element includes the acquisition, configuration, test, packing, and shipping of infrastructure for the Base Center.

02C.07.04.04 Chilean DAC Infrastructure

This WBS element includes the acquisition, configuration, test, packing, and shipping of infrastructure for the Chilean DAC.

02C.07.04.05 Development and Integration Infrastructure

This WBS element is a summary element and includes the acquisition, configuration, test, and operation of the Development and Integration clusters at the Archive Site.

02C.07.04.05.01 Development Cluster and Workstations

This WBS element includes a computing system that is architecturally the same as the Base Center infrastructure, but on a smaller scale in terms capacity/performance. It is used as a DMS software development and maintenance environment during Construction and Operations. It includes at least one of each type of DMS workstation, server, and communications end equipment.

02C.07.04.05.02 Integration Cluster

This WBS element includes a computing system that is architecturally the same as the Archive Facility infrastructure, but on a smaller scale in terms of capacity/performance. It is used as a DMS integration environment during Construction and a support environment during Operations. This environment is the primary environment for duplicating/debugging DMS operational problems. During major DMS upgrades, the environment provides for a testing period in which the newly upgraded system operates in parallel with the current operational system to ensure smooth cut-over.

WBS element includes all DM activities in support of overall LSST Science Verification.