Vera C. Rubin Observatory
Data Management

Vera C. Rubin Observatory Network Verification Document

Joshua Hoblitt, Jeff Kantor

LDM-732

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Abstract

The Vera C Rubin Observatory Network Verification Document (VNVD) and associated JIRA V&V Project define the flow-down of specifications from higher level documents to the LSST Observatory Network (as defined in LSE-78 LSST Observatory Network), and the methods and resources that will be used to verify that the networks have met the specifications satisfactory for accepting the Summit Network into DM Subsystem Integration Test (DMSSIT) and LSST System Integration Test (SIT)

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Change Record

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1 Introduction

1.1 Scope

This plan governs only tests of the network infrastructure, not the applications and services that use the network. To be specific, this plan governs tests of the network only up to ISO OSI Layer `https://en.wikipedia.org/wiki/OSI_model`.

As such, all of the tests governed by this plan and defined in the LSST Verification and Validation JIRA Project (LVV) are defined as Lower Level (LL) in the System Engineering test hierarchy. LL corresponds to Data Management Subsystem Integration. Where appropriate, additional comments regarding Same Level (SL) which corresponds to LSST System Integration, and Higher Level (HL) which corresponds to LSST Commissioning, are called out in the Verification Elements.

Note that significant testing of the networks occurs prior to subsystem and system integration, i.e. prior to verification, as documented in document-14789 LSST LHN End-to-End Plan and associated test documentation (see Collection-3758).

Finally, note that one significant network, the Summit Network, is not a DM deliverable and as such is not contained within this plan. As Telescope and Site deliverable, the Summit Network is covered by the Telescope and Site V&V plans.

1.2 Specification Flow-down

1.2.1 Data Management Subsystem Requirements Flow-down

The Data Management Subsystem Requirements (LSE-61, aka DMSR) drive the LSST Observatory Network Design for all segments except the Summit Network (see above). The DMSR sections that directly drive the VNVD are listed here for convenience. These DMSR sections contain traceable network requirements as documented in the LSST V&V JIRA Project (LVV) Verification Elements:

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- 1.2.1 Nightly Data Accessible Within 24 hrs

- 2.6.3 Transient Alert Distribution

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- 2.8.1 Timely Publication of Level 2 Data Releases

- 4.4 Summit to Base

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- 4.8 Archive to Data Access Center

1.2.2 Observatory System Specifications Flow-down

Note that the Observatory System Specifications (LSE-30, aka OSS) also include general requirements on security, disaster recovery, physical environment (including seismic activity), and shipping which are flowed down to the subsystems, and while they apply to all subsystems, including the networks, they will be tested and verified in the Telescope and Data Management Subsystem Integration Tests and in the LSST Commissioning Phase, as part of the LSST System Integration Test. Those requirements are excluded from this specification and the associated verification matrix, as they will be addressed in the applicable plans.

1.3 LSST Verification and Validation JIRA Project (LVV)

The LSST Verification and Validation JIRA Project lists the specifications within or derived from, and traceable to, the DMSR specifications, in Verification Elements that also specify the methods to be used to verify, the responsible parties, and additional notes regarding verification, per the LSE-160 LSST Verification and Validation Process. The Verification Elements then have one or more Test Cases associated with them that describe the implementation of the verification activities in terms of specific tests to be executed. Those Test Cases are then scheduled via Test Plans and Campaigns, and executed with results reported in Test Cycles/

1.4 Verification and Validation Schedule and Resources

The schedule and resources required for network verification are defined in the LSST Project Management Control System (PMCS). They are covered by the final integration test activities

in the WBS elements 02C.08.03 Long-Haul Networks. In each Verification Element, a cross-reference to the ID of the appropriate predecessor PMCS activities is provided in the pre-conditions field.

1.5   Applicable Documents

LSE-61   LSST DM Subsystem Requirements
LSE-78   LSST Observatory Network Design
LSE-160   Verification and Validation Process

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2   DM Network Verification Elements

The following is the list of verification elements defined in the context of the Network component of the DM subsystem.

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2.1 [LVV-71] DMS-REQ-0168-V-01: Summit Facility Data Communications

Jira Link	Assignee	Status	Priority	Test Cases
LVV-71	Gregory Dubois-Felsmann	Covered	1a	LVV-T1097 LVV-T2338

Verification Element Description:

Verify that:

- Summit - Base Network has been properly implemented in Summit and Base facilities
- Summit - Base Network is properly integrated with Summit Control Network and DAQ/-Camera Data Backbone

Verify that OCS/DMCS triggers read-out from DAQ and queries EFD. verify that data from EFD and camera are accepted and transferred to the Summit DWDM. Requirement does not include data transfer to base (LVV-73) or from base to archive center (LVV-81, LVV-82, LVV-83).

Upstream Requirements	
Requirement ID	DMS-REQ-0168
Requirement Description	**Specification:** The DMS shall provide data communications infrastructure to accept science data and associated metadata read-outs, and the collection of ancillary and engineering data, for transfer to the base facility.
Requirement Priority	1a
Upper Level Requirement	OSS-REQ-0002 The Summit Facility

2.1.1 [LVV-T1097] Verify Summit Facility Network Implementation

Test Case Summary					
Jira Link	Owner	Status	Version	Critical Event	Verification Type
LVV-T1097	Jeff Kantor	Draft	1	false	Test

Objective:

Verify that data acquired by a AuxTel DAQ can be transferred to Summit DWDM and loaded

in the EFD without problems.

Precondition:

1. Summit Control Network and Camera Data Backbone installed and operating properly.
2. Summit - Base Network installed and operating properly.
3. EITHER: AuxTel hardware and control systems are functional with LATISS. AuxTel TCS, AuxTel EFD, AuxTel CCS, AuxTel DAQ are connected via Control Network on Summit to Rubin Observatory DWDM (with at least 2 x 10 Gbps ethernet port client cards) OR: high-quality DAQ application-level simulators that match the form, volume, file paths, compressibility, and cadence of the expected instrument data, running on end node computers that are the production hardware or equivalent to it. Scientific validity of the data content is not essential.
4. AuxTel Archiver/forwarders installed in Summit and operating properly running on end node computers that are the production hardware or equivalent to it.
5. As-built documentation for all of the above is available.

NOTE: This test will be repeated at increasing data volumes as additional observatory capabilities (e.g. ComCAM, LSSTCam) become available. Final verification will be tested at full operational volume. After the initial test, the corresponding verification elements will be flagged as "Requires Monitoring" such that those requirements will be closed out as having been verified but will continue to be monitored throughout commissioning to ensure they do not drop out of compliance. This will also be monitored for end to end Summit - Data Facility transfers during Commissioning.

Predecessors:
PMCS DMTC-7400-2400 Complete
PMCS T&SC-2600-1545 Complete

Test Personnel:
Ron Lambert (Rubin Observatory), Kian-Tat Lim (Rubin Observatory), Matt Kollross (NCSA), Tony Johnson (SLAC), Gregg Thayer (SLAC)

2.1.2 [LVV-T2338] Replicated telemetry data agrees with telemetry produced at the summit

Test Case Summary					
Jira Link	Owner	Status	Version	Critical Event	Verification Type
LVV-T2338	Simon Krughoff	Defined	1	false	Demonstration

Objective:

Show that telemetry data can be accessed from the replicated EFD. Â Further, show that the values in the replicated database agree with the values in the summit EFD over a specified time range and set of topics.

This test case provides partial coverage of the requirement DMS-REQ-0168, Summit Facility Data Communications: "The DMS shall provide data communications infrastructure to accept science data and associated metadata read-outs, and **the collection of ancillary and engineering data**, for transfer to the base facility.", as adapted to the current design for EFD replication (see DMTN-082).

Precondition:
See prerequisites in the Test Plan LVV-P90

Predecessors:

Test Personnel:

2.2   [LVV-73] DMS-REQ-0171-V-01: Summit to Base Network

Jira Link	Assignee	Status	Priority	Test Cases
LVV-73	Leanne Guy	In Verification	1a	LVV-T1168
				LVV-T1612

Verification Element Description:

This requirement must be tested in sequence and collect performance metrics (both DAQ and Control sides unless noted):

1. ISO OSI Layer 1 Physical (fibers with test data from OTDR, AURA does test)
2. ISO OSI Layer 2 Data Link (DWDM equipment, line cards, with test data from multi-channel/lightwave/channel analyzer, Installer does test, AURA certify)
3. ISO Layer 3 minimal (DWDM with 2 x 10 Gbps ethernet port client cards with test data from 4 windows test boxes, 2 on each side, Installer does test, AURA certify, can repeat as part of #4 with DAQ)
4. ISO Layer 3 full (22 x 10 Gbps ethernet ports on DAQ side with test data from DAQ test stand, AURA, Camera DAQ team do test). Transfer data between summit and base over uninterrupted 1 day period. Â Demonstrate transfer of data at or exceeding rates specified in LDM-142.

Upstream Requirements	
Requirement ID	DMS-REQ-0171
Requirement Description	**Specification:** The DMS shall provide communications infrastructure between the Summit Facility and the Base Facility sufficient to carry scientific data and associated metadata for each image in no more than time **summmToBaseMaxTransferTime**.
Requirement Parameters	**summmToBaseMaxTransferTime = 2[second]** Maximum time interval to transfer a full Crosstalk Corrected Exposure and all related metadata from the Summit Facility to the Base facility.
Requirement Priority	1a
Upper Level Requirement	OSS-REQ-0003 The Base Facility OSS-REQ-0127 Level 1 Data Product Availability

2.2.1   [LVV-T1168] Verify Summit - Base Network Integration

Test Case Summary					
Jira Link	Owner	Status	Version	Critical Event	Verification Type
LVV-T1168	Jeff Kantor	Approved	1	false	Inspection

Objective:

Verify the integration of the summit to base network by demonstrating a sustained and uninterrupted transfer of data between summit and base over 1 day period at or exceeding rates specified in LDM-142. Done in 3 phases in collaboration with equipment/installation vendors (see test procedure).

Precondition:

PMCS DMTC-7400-2330 COMPLETE

By phase:

1. Posts from Cerro Pachon to AURA Gatehouse repaired/improved. Fiber installed on posts from Cerro Pachon to AURA Gatehouse. Fiber installed from AURA Gatehouse to AURA compound in La Serena. OTDR purchased.
2. AURA DWDM installed in caseta on Cerro Pachon and in existing computer room in La Serena. DTN installed in La Serena. DTN loaded with software and test data staged.
3. Base Data Center (BDC) ready for installation of LSST DWDM. Fiber connecting existing computer room to BDC. LSST DWDM equipment installed in Summit Computer Room and BDC.

Predecessors:

See pre-conditions by phase above.

Test Personnel:

Ron Lambert (LSST), Albert Astudillo (REUNA), Mauricio Rojas (CTIO/CISS), Raylex, Coriant, Telefonica contractors

2.2.2 [LVV-T1612] Verify Summit - Base Network Integration (System Level)

Test Case Summary

Jira Link	Owner	Status	Version	Critical Event	Verification Type
LVV-T1612	Jeff Kantor	Draft	1	false	Inspection

Objective:

Verify ISO Layer 3 full (22 x 10 Gbps ethernet ports on DAQ side with test data from DAQ test stand, AURA, Camera DAQ team do test). Demonstrate transfer of data at or exceeding rates specified in LDM-142.

Precondition:

1. PMCS DMTC-7400-2400 COMPLETE
2. LVV-T1168 Passed
3. EITHER: Full Camera DAQ installed on summit and loaded with data OR: high-quality DAQ application-level simulators that match the form, volume, file paths, compressibility, and cadence of the expected instrument data, running on end node computers that are the production hardware or equivalent to it. Scientific validity of the data content is not essential.
4. Archiver/forwarders installed at Base running on end node computers that are the production hardware or equivalent to it.
5. As-built documentation for all of the above is available.

NOTE: This test will be repeated at increasing data volumes as additional observatory capabilities (e.g. ComCAM, FullCam) become available. Final verification will be tested at full operational volume.After the initial test, the corresponding verification elements will be flagged as "Requires Monitoring" such that those requirements will be closed out as having been verified but will continue to be monitored throughout commissioning to ensure they do not drop out of compliance. This will also be monitored for end to end Summit - Data Facility transfers during Commissioning.

Predecessors:
See pre-conditions.

Test Personnel:

Ron Lambert (LSST), Greg Thayer (SLAC)

2.3   [LVV-74] DMS-REQ-0172-V-01: Summit to Base Network Availability

Jira Link	Assignee	Status	Priority	Test Cases
LVV-74	Leanne Guy	Covered	1b	LVV-T185

Verification Element Description:

This requirement needs the network link to be active for a calculated amount of time (at least 1 week) without failure. Will require extrapolating from test and historical data as failures are rare. Monthly operating statistics will be acquired during commissioning. Demonstrate transfer of data at or exceeding rates specified in LDM-142, verify achieved average and peak throughput and latency.

Upstream Requirements	
Requirement ID	DMS-REQ-0172
Requirement Description	**Specification:** The Summit to Base communications shall be highly available, with Mean Time Between Failures (MTBF) > **summToBaseNetMTBF**.
Requirement Parameters	**summToBaseNetMTBF = 90[day]** Mean time between failures, measured over a 1-yr period.
Requirement Priority	1b
Upper Level Requirement	OSS-REQ-0373 Unscheduled Downtime Subsystem Allocations DMS-REQ-0161 Optimization of Cost, Reliability and Availability in Order

2.3.1   [LVV-T185] Verify implementation of Summit to Base Network Availability

Test Case Summary					
Jira Link	Owner	Status	Version	Critical Event	Verification Type
LVV-T185	Jeff Kantor	Draft	1	false	Inspection

Objective:

Verify the availability of Summit to Base Network by demonstrating that the mean time between failures is less than summToBaseNetMTBF (90 days) over 1 year.

Precondition:

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1. PMCS DMTC-7400-2400 Complete.
2. 6 months of historical availability data for this link is available.
3. perSonar installed in Summit and publishing statistics to MadDash.
4. As-built documentation for all of the above is available.

NOTE: After the initial test, the corresponding verification elements will be flagged as "Requires Monitoring" such that those requirements will be closed out as having been verified but will continue to be monitored throughout commissioning to ensure they do not drop out of compliance. This will also be monitored for end to end Summit - Data Facility transfers during Commissioning.

Predecessors:
See pre-conditions.

Test Personnel:
Ron Lambert (LSST)

2.4 [LVV-75] DMS-REQ-0173-V-01: Summit to Base Network Reliability

Jira Link	Assignee	Status	Priority	Test Cases
LVV-75	Leanne Guy	Covered	1b	LVV-T186

Verification Element Description:

Disconnect, reconnect and recover transfer of data between summit and base. After disconnecting fiber at an intermediate location between summit and base, demonstrate reconnection and recovery to transfer of data at or exceeding rates specified in LDM-142 within MTTR specification. Â Network operator will provide MTTR data on links during commissioning and operations.

Upstream Requirements	
Requirement ID	DMS-REQ-0173
Requirement Description	**Specification:** The Summit to Base communications shall be highly reliable, with Mean Time to Repair (MTTR) < **summToBaseNetMTTR**.
Requirement Parameters	**summToBaseNetMTTR = 24[hour]** Mean time to repair, measured over a 1-yr period.
Requirement Priority	1b
Upper Level Requirement	OSS-REQ-0373 Unscheduled Downtime Subsystem Allocations DMS-REQ-0161 Optimization of Cost, Reliability and Availability in Order

2.4.1 [LVV-T186] Verify implementation of Summit to Base Network Reliability

Test Case Summary					
Jira Link	Owner	Status	Version	Critical Event	Verification Type
LVV-T186	Jeff Kantor	Draft	1	false	Demonstration

Objective:

Verify the reliability of the summit to base network by demonstrating reconnection and recovery to transfer of data at or exceeding rates specified in LDM-142 following a cut in network connection, within MTTR specification. The network operator will provide MTTR data on links during commissioning and operations.

Precondition:

1. PMCS DMTC-7400-2400 Complete
2. As-built documentation for Summit - Base Network is available.

NOTE: After the initial test, the corresponding verification elements will be flagged as "Requires Monitoring" such that those requirements will be closed out as having been verified but will continue to be monitored throughout commissioning to ensure they do not drop out of compliance. This will also be monitored for end to end Summit - Data Facility transfers during Commissioning.

Predecessors:
See pre-conditions.

Test Personnel:
Ron Lambert (LSST), Guido Maulen (LSST)

2.5   [LVV-76] DMS-REQ-0174-V-01: Summit to Base Network Secondary Link

Jira Link	Assignee	Status	Priority	Test Cases
LVV-76	Leanne Guy	Covered	1b	LVV-T187

Verification Element Description:

This requirement is verified by demonstrating use of a secondary transfer method (redundant fiber network, microwave link, or transportable medium) between Summit and Base capable of transferring 1 night of raw data (nCalibExpDay + nRawExpNightMax = 450 + 2800 = 3250 exposures) within summToBaseNet2TransMax (72 hours).

Upstream Requirements	
Requirement ID	DMS-REQ-0174
Requirement Description	**Specification:** The Summit to Base communications shall provide at least one secondary link or transport mechanism for minimal operations support in the event of extended outage. This link may include redundant fiber optics, microwaves, or transportable media. It shall be capable of transferring one night's worth of raw data in **summToBaseNet2TransMax** or less.
Requirement Parameters	**summToBaseNet2TransMax = 72[hour]** Maximum time to transfer one night of data via the network secondary link.
Requirement Priority	1b
Upper Level Requirement	DMS-REQ-0173 Summit to Base Network Reliability OSS-REQ-0049 Degraded Operational States DMS-REQ-0172 Summit to Base Network Availability

2.5.1   [LVV-T187] Verify implementation of Summit to Base Network Secondary Link

Test Case Summary					
Jira Link	Owner	Status	Version	Critical Event	Verification Type
LVV-T187	Jeff Kantor	Draft	1	false	Test

Objective:

Verify automated fail-over from primary to secondary equipment in Rubin Observatory DWDM on simulated failure of primary.   Verify bandwidth sufficiency on secondary.   Verify automated recovery to primary equipment on simulated restoration of primary.   Repeat for failure of Rubin Observatory fiber and fail-over to AURA fiber and DWDM. Demonstrate use of

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secondary in "catch-up" mode.

Precondition:

1. PMCS DMTC-7400-2400 complete.
2. As-built documentation for Summit - Base Network is available.

NOTE: After the initial test, the corresponding verification elements will be flagged as "Requires Monitoring" such that those requirements will be closed out as having been verified but will continue to be monitored throughout commissioning to ensure they do not drop out of compliance. This will also be monitored for end to end Summit - Data Facility transfers during Commissioning.

Predecessors:
See pre-conditions.

Test Personnel:
Ron Lambert (LSST)

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2.6 [LVV-77] DMS-REQ-0175-V-01: Summit to Base Network Ownership and Operation

Jira Link	Assignee	Status	Priority	Test Cases
LVV-77	Leanne Guy	Covered	1b	LVV-T188

Verification Element Description:

This requirement is verified by inspecting construction and operations contracts and Indefeasible Rights to Use (IRUs).

Upstream Requirements		
Requirement ID	DMS-REQ-0175	
Requirement Description	**Specification:** The Summit to Base communications link shall be owned and operated by LSST and/or the operations entity to ensure responsiveness of support.	
Requirement Priority	1b	
Upper Level Requirement	DMS-REQ-0173	Summit to Base Network Reliability
	OSS-REQ-0036	Local Autonomous Administration of System Sites
	DMS-REQ-0172	Summit to Base Network Availability

2.6.1 [LVV-T188] Verify implementation of Summit to Base Network Ownership and Operation

Test Case Summary					
Jira Link	**Owner**	**Status**	**Version**	**Critical Event**	**Verification Type**
LVV-T188	Jeff Kantor	Draft	1	false	Inspection

Objective:

Verify Summit to Base Network Ownership and Operation by LSST and/or the operations entity by inspection of construction and operations contracts and Indefeasible Rights.

Precondition:

1. As-built documentation for all of the above contracts and IRUs is available.

Predecessors:

PMCS DMTC-7400-2140, -2240, -2330 Complete

Test Personnel:

Jeff Kantor (LSST)

2.7   [LVV-81] DMS-REQ-0180-V-01: Base to Archive Network

Jira Link	Assignee	Status	Priority	Test Cases
LVV-81	Leanne Guy	Covered	1b	LVV-T193

Verification Element Description:

This requirement is verified by transferring simulated or pre-cursor image data and meta-data between base and archive over an uninterrupted 1 day period. Â Analyze the network performance and show that data can be transferred by DAQ within the required time.

Upstream Requirements	
Requirement ID	DMS-REQ-0180
Requirement Description	**Specification:** The DMS shall provide communications infrastructure between the Base Facility and the Archive Center sufficient to carry scientific data and associated metadata for each image in no more than time **baseToArchiveMaxTransferTime**.
Requirement Parameters	**baseToArchiveMaxTransferTime = 5[second]** Maximum time interval to transfer a full Crosstalk Corrected Exposure and all related metadata from the Base Facility to the Archive Center.
Requirement Priority	1b
Upper Level Requirement	OSS-REQ-0053 Base-Archive Connectivity Loss OSS-REQ-0055 Base Updating from Archive DMS-REQ-0162 Pipeline Throughput

2.7.1   [LVV-T193] Verify implementation of Base to Archive Network

Test Case Summary					
Jira Link	Owner	Status	Version	Critical Event	Verification Type
LVV-T193	Jeff Kantor	Draft	1	false	Test

Objective:

Verify that the data acquired by a DAQ can be transferred within the required time, i.e. verify that link is capable of transferring image for prompt processing in oArchiveMaxTransferTime = 5[second], i.e. at or exceeding rates specified in LDM-142.

Precondition:

1. Archiver/Forwarders are configured at Base, connected to REUNA DWDM, loaded with simulated or pre-cursor data, running on end node computers that are the production hardware or equivalent to it.
2. Archiver/Forwarder receivers or other capability is on configured at LDF, connected to Base - Archive Network, running on end node computers that are the production hardware or equivalent to it.
3. As-built documentation for all of the above is available.

NOTE: This test will be repeated at increasing data volumes as additional observatory capabilities (e.g. ComCAM, FullCam) become available. Final verification will be tested at full operational volume. After the initial test, the corresponding verification elements will be flagged as "Requires Monitoring" such that those requirements will be closed out as having been verified but will continue to be monitored throughout commissioning to ensure they do not drop out of compliance. This will also be monitored for end to end Summit - Data Facility transfers during Commissioning.

Predecessors:
PMCS DM-Net-5 Complete

Test Personnel:
Josh Hoblitt (Rubin Obs), Renata Frez (FIU/AmLight), Matt Kollross (NCSA)

2.8 [LVV-82] DMS-REQ-0181-V-01: Base to Archive Network Availability

Jira Link	Assignee	Status	Priority	Test Cases
LVV-82	Leanne Guy	Covered	1b	LVV-T194

Verification Element Description:

This requirement is verified by transferring data between base and archive over uninterrupted 1 week period, modeling to extrapolate to an annual failure rate, and verifying that is within the requirement.

Upstream Requirements		
Requirement ID	DMS-REQ-0181	
Requirement Description	**Specification:** The Base to Archive communications shall be highly available, with MTBF > **baseToArchNetMTBF**.	
Requirement Parameters	**baseToArchNetMTBF = 180[day]** Mean time between failures, measured over a 1-yr period.	
Requirement Priority	1b	
Upper Level Requirement	OSS-REQ-0053	Base-Archive Connectivity Loss
	DMS-REQ-0162	Pipeline Throughput
	DMS-REQ-0161	Optimization of Cost, Reliability and Availability in Order

2.8.1 [LVV-T194] Verify implementation of Base to Archive Network Availability

Test Case Summary					
Jira Link	Owner	Status	Version	Critical Event	Verification Type
LVV-T194	Jeff Kantor	Draft	1	false	Test

Objective:

Verify the availability of the Base to Archive Network communications by demonstrating that it meets or exceeds a mean time between failures, measured over a 1-yr period of MTBF > baseToArchNetMTBF (180[day])

Precondition:

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1. Archiver/Forwarders are configured at Base, connected to REUNA DWDM, loaded with simulated or pre-cursor data, running on end node computers that are the production hardware or equivalent to it.
2. Archiver/Forwarder receivers or other capability is on configured at LDF, connected to Base - Archive Network, running on end node computers that are the production hardware or equivalent to it.
3. At least 6 months of historical monitoring data on this link is available.
4. As-built documentation for all of the above is available.

NOTE: This test will be repeated at increasing data volumes as additional observatory capabilities (e.g. ComCAM, FullCam) become available. Final verification will be tested at full operational volume. After the initial test, the corresponding verification elements will be flagged as "Requires Monitoring" such that those requirements will be closed out as having been verified but will continue to be monitored throughout commissioning to ensure they do not drop out of compliance. This will also be monitored for end to end Summit - Data Facility transfers during Commissioning.

Predecessors:
PMCS DMTC-7400-2130 Complete

Test Personnel:
Josh Hoblitt (Rubin Obs), Renata Frez (FIU/AmLight), Matt Kollross (NCSA)

2.9 [LVV-83] DMS-REQ-0182-V-01: Base to Archive Network Reliability

Jira Link	Assignee	Status	Priority	Test Cases
LVV-83	Leanne Guy	Covered	1b	LVV-T195

Verification Element Description:

Disconnect, reconnect and recover transfer of data between summit and base, after disconnecting fiber at an intermediate location between base and archive

Upstream Requirements		
Requirement ID	DMS-REQ-0182	
Requirement Description	**Specification:** The Base to Archive communications shall be highly reliable, with MTTR < **baseToArchNetMTTR**.	
Requirement Parameters	**baseToArchNetMTTR = 48[hour]** Mean time to repair, measured over a 1-yr period.	
Requirement Priority	1b	
Upper Level Requirement	OSS-REQ-0053	Base-Archive Connectivity Loss
	DMS-REQ-0161	Optimization of Cost, Reliability and Availability in Order

2.9.1 [LVV-T195] Verify implementation of Base to Archive Network Reliability

Test Case Summary					
Jira Link	Owner	Status	Version	Critical Event	Verification Type
LVV-T195	Jeff Kantor	Draft	1	false	Test

Objective:

Verify Base to Archive Network Reliability by demonstrating that the network can recover from outages within baseToArchNetMTTR = 48[hour].

Precondition:

1. Archiver/Forwarders are configured at Base, connected to REUNA DWDM, loaded with simulated or pre-cursor data, running on end node computers that are the production hardware or equivalent to it.

2. Archiver/Forwarder receivers or other capability is on configured at LDF, connected to Base - Archive Network, running on end node computers that are the production hardware or equivalent to it.
3. At least 6 months of monitoring data for this link is available.
4. As-built documentation for all of the above is available.

NOTE: This test will be repeated at increasing data volumes as additional observatory capabilities (e.g. ComCAM, FullCam) become available. Final verification will be tested at full operational volume. After the initial test, the corresponding verification elements will be flagged as "Requires Monitoring" such that those requirements will be closed out as having been verified but will continue to be monitored throughout commissioning to ensure they do not drop out of compliance. This will also be monitored for end to end Summit - Data Facility transfers during Commissioning.

Predecessors:
PMCS DM-NET-5 Complete

Test Personnel:
Josh Hoblitt (Rubin Obs), Renata Frez (FIU/AmLight), Matt Kollross (NCSA)

2.10 [LVV-84] DMS-REQ-0183-V-01: Base to Archive Network Secondary Link

Jira Link	Assignee	Status	Priority	Test Cases
LVV-84	Leanne Guy	Covered	1b	LVV-T196

Verification Element Description:

This requirement is verified by disconnecting the primary link, failing over to the secondary link, reconnecting primary link, and failing back to primary link, while verifying data is transferred within required times.

Upstream Requirements	
Requirement ID	DMS-REQ-0183
Requirement Description	**Specification:** The Base to Archive communications shall provide a secondary link or transport mechanism (e.g. protected circuit) for operations support and "catch up" in the event of extended outage which is capable of transferring data at least the same rate as the required minimum capacity of the primary link.
Requirement Priority	1b
Upper Level Requirement	DMS-REQ-0181 Base to Archive Network Availability DMS-REQ-0182 Base to Archive Network Reliability OSS-REQ-0049 Degraded Operational States

2.10.1 [LVV-T196] Verify implementation of Base to Archive Network Secondary Link

Test Case Summary					
Jira Link	Owner	Status	Version	Critical Event	Verification Type
LVV-T196	Jeff Kantor	Draft	1	false	Test

Objective:

Verify Base to Archive Network Secondary Link failover and capacity, and subsequent recovery primary. Demonstrate the use of the secondary path in "catch-up" mode.

Precondition:

1. Archiver/Forwarders are configured at Base, connected to REUNA DWDM, loaded with

simulated or pre-cursor data, running on end node computers that are the production hardware or equivalent to it.

2. Archiver/Forwarder receivers or other capability is on configured at LDF, connected to Base - Archive Network, running on end node computers that are the production hardware or equivalent to it.

3. As-built documentation for all of the above is available.

NOTE: This test will be repeated at increasing data volumes as additional observatory capabilities (e.g. ComCAM, FullCam) become available. Final verification will be tested at full operational volume. After the initial test, the corresponding verification elements will be flagged as "Requires Monitoring" such that those requirements will be closed out as having been verified but will continue to be monitored throughout commissioning to ensure they do not drop out of compliance. This will also be monitored for end to end Summit - Data Facility transfers during Commissioning.

Predecessors:
PMCS DM-NET-5 Complete
PMCS DMTC-8000-0990 Complete
PMCS DMTC-8100-2130 Complete
PMCS DMTC-8100-2530 Complete
PMCS DMTC-8200-0600 Complete

Test Personnel:
Josh Hoblitt (Rubin Obs), Renata Frez (FIU/AmLight), Matt Kollross (NCSA)

2.11 [LVV-88] DMS-REQ-0188-V-01: Archive to Data Access Center Network

Jira Link	Assignee	Status	Priority	Test Cases
LVV-88	Leanne Guy	Covered	1b	LVV-T200

Verification Element Description:

This requirement is verified by transferring data between archive and both DACs over uninterrupted 1 day period, analyzing the network performance, and verifying that data can be transferred within the required time.

Upstream Requirements	
Requirement ID	DMS-REQ-0188
Requirement Description	**Specification:** The DMS shall provide communications infrastructure between the Archive Center and Data Access Centers sufficient to carry scientific data and associated metadata in support of community and EPO access. Aggregate bandwidth for data transfers from the Archive Center to Data Centers shall be at least **archToDacBandwidth**.
Requirement Parameters	**archToDacBandwidth = 10000[megabit per second]** Aggregate bandwidth capacity for data transfers between the Archive and Data Access Centers.
Requirement Priority	1b
Upper Level Requirement	

2.11.1 [LVV-T200] Verify implementation of Archive to Data Access Center Network

Test Case Summary					
Jira Link	Owner	Status	Version	Critical Event	Verification Type
LVV-T200	Jeff Kantor	Draft	1	false	Test

Objective:

Verify archiving of data to Data Access Center Network at or exceeding rates specified in LDM-142, i.e at archToDacBandwidth = 10000[megabit per second].

Precondition:

1. Data is staged in LDF and data transfer capabilities to US DAC and Chilean DAC are in

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place, running on end node computers that are the production hardware or equivalent to it.

2. At least 6 months of historical monitoring data is available on these network links.
3. As-built documentation for all of the above is available.

NOTE: This test will be repeated at increasing data volumes as additional observatory capabilities (e.g. ComCAM, LSSTCam) become available. Final verification will be tested at full operational volume. After the initial test, the corresponding verification elements will be flagged as "Requires Monitoring" such that those requirements will be closed out as having been verified but will continue to be monitored throughout commissioning to ensure they do not drop out of compliance. This will also be monitored for end to end Summit - Data Facility transfers during Commissioning.

Predecessors:
PMCS DMTC-8100-2550 Complete

Test Personnel:
Ron Lambert (LSST), Albert Astudillo (REUNA), Jeronimo Bezerra (FIU/AmLight), Matt Kollross (NCSA)

2.12 [LVV-89] DMS-REQ-0189-V-01: Archive to Data Access Center Network Availability

Jira Link	Assignee	Status	Priority	Test Cases
LVV-89	Leanne Guy	Covered	1b	LVV-T201

Verification Element Description:

This requirement needs the network link to be active for a calculated amount of time (at least 1 week) without failure. This will require modeling as failures are rare, so an annual MTBF will be estimated from test results.

Upstream Requirements	
Requirement ID	DMS-REQ-0189
Requirement Description	**Specification:** The Archive to Data Access Center communications shall be highly available, with MTBF > **archToDacNetMTBF**.
Requirement Parameters	**archToDacNetMTBF = 180[day]** Mean Time Between Failures for data service between Archive and DACs, averaged over a one-year period.
Requirement Priority	1b
Upper Level Requirement	DMS-REQ-0161 Optimization of Cost, Reliability and Availability in Order

2.12.1 [LVV-T201] Verify implementation of Archive to Data Access Center Network Availability

Test Case Summary					
Jira Link	Owner	Status	Version	Critical Event	Verification Type
LVV-T201	Jeff Kantor	Draft	1	false	Test

Objective:

Verify availability of archiving to Data Access Center Network using test and historical data of or exceeding archToDacNetMTBF= 180[day].

Precondition:

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1. Data is staged in LDF and data transfer capabilities to US DAC and Chilean DAC are in place, running on end node computers that are the production hardware or equivalent to it.
2. At least 6 months of historical monitoring data is available on these network links, running on end node computers that are the production hardware or equivalent to it.
3. As-built documentation for all of the above is available.

NOTE: This test will be repeated at increasing data volumes as additional observatory capabilities (e.g. ComCAM, FullCam) become available. Final verification will be tested at full operational volume. After the initial test, the corresponding verification elements will be flagged as "Requires Monitoring" such that those requirements will be closed out as having been verified but will continue to be monitored throughout commissioning to ensure they do not drop out of compliance. This will also be monitored for end to end Summit - Data Facility transfers during Commissioning.

Predecessors:
PMCS DMTC-8100-2550 Complete

Test Personnel:
Ron Lambert (LSST), Albert Astudillo (REUNA), Jeronimo Bezerra (FIU/AmLight), Matt Kollross (NCSA)

2.13 [LVV-90] DMS-REQ-0190-V-01: Archive to Data Access Center Network Reliability

Jira Link	Assignee	Status	Priority	Test Cases
LVV-90	Leanne Guy	Covered	1b	LVV-T202

Verification Element Description:

This requirement is verified by reconnecting and recovering transfer of data between archive and DACs, after disconnecting fiber at an intermediate location between archive and DACs.

Upstream Requirements	
Requirement ID	DMS-REQ-0190
Requirement Description	**Specification:** The Archive to Data Access Center communications shall be highly reliable, with MTTR < **archToDacNetMTTR**.
Requirement Parameters	**archToDacNetMTTR = 48[hour]** Mean time to repair, measured over a 1-yr period.
Requirement Priority	1b
Upper Level Requirement	DMS-REQ-0161 Optimization of Cost, Reliability and Availability in Order

2.13.1 [LVV-T202] Verify implementation of Archive to Data Access Center Network Reliability

Test Case Summary					
Jira Link	Owner	Status	Version	Critical Event	Verification Type
LVV-T202	Jeff Kantor	Draft	1	false	Test

Objective:

Verify the reliability of Archive to Data Access Center Network by demonstrating successful failover and capacity to the secondary part and subsequent recovery to primary within or exceeding chToDacNetMTTR = 48[hour].

Precondition:

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1. Data is staged in LDF and data transfer capabilities to US DAC and Chilean DAC are in place, running on end node computers that are the production hardware or equivalent to it.
2. As-built documentation for all of the above is available.
3. NOTE: This test will be repeated at increasing data volumes as additional observatory capabilities (e.g. ComCAM, LSSTCam) become available. Final verification will be tested at full operational volume. After the initial test, the corresponding verification elements will be flagged as "Requires Monitoring" such that those requirements will be closed out as having been verified but will continue to be monitored throughout commissioning to ensure they do not drop out of compliance. This will also be monitored for end to end Summit - Data Facility transfers during Commissioning.

Predecessors:

PMCS DMTC-8100-2550 Complete

Test Personnel:

Ron Lambert (LSST), Albert Astudillo (REUNA), Jeronimo Bezerra (FIU/AmLight), Matt Kollross (NCSA)

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2.14 [LVV-91] DMS-REQ-0191-V-01: Archive to Data Access Center Network Secondary Link

Jira Link	Assignee	Status	Priority	Test Cases
LVV-91	Leanne Guy	Covered	1b	LVV-T203

Verification Element Description:

This requirement is verified by reconnecting and recovering transfer of data between archive and DACs, after disconnecting fiber at an intermediate location between archive and DACs.

Upstream Requirements	
Requirement ID	DMS-REQ-0191
Requirement Description	**Specification:** The Archive to Data Access Center communications shall provide secondary link or transport mechanism (e.g. protected circuit) for operations support and "catch up" in the event of extended outage.
Requirement Priority	1b
Upper Level Requirement	DMS-REQ-0189 Archive to Data Access Center Network Availability DMS-REQ-0190 Archive to Data Access Center Network Reliability

2.14.1 [LVV-T203] Verify implementation of Archive to Data Access Center Network Secondary Link

Test Case Summary					
Jira Link	Owner	Status	Version	Critical Event	Verification Type
LVV-T203	Kian-Tat Lim	Draft	1	false	Test

Objective:

Verify the Archive to Data Access Center Network via Secondary Link by simulating a failure on the primary path and capacity on the secondary path.

Precondition:

1. Data is staged in LDF and data transfer capabilities to US DAC and Chilean DAC are in place, running on end node computers that are the production hardware or equivalent

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to it.

2. As-built documentation for all of the above is available.

NOTE: This test will be repeated at increasing data volumes as additional observatory capabilities (e.g. ComCAM, FullCam) become available. Final verification will be tested at full operational volume. After the initial test, the corresponding verification elements will be flagged as "Requires Monitoring" such that those requirements will be closed out as having been verified but will continue to be monitored throughout commissioning to ensure they do not drop out of compliance. This will also be monitored for end to end Summit - Data Facility transfers during Commissioning.

Predecessors:

PMCS DMTC-8100-2550 Complete

Test Personnel:

Ron Lambert (LSST), Albert Astudillo (REUNA), Jeronimo Bezerra (FIU/AmLight), Matt Kollross (NCSA)

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2.15 [LVV-183] DMS-REQ-0352-V-01: Base Wireless LAN (WiFi)

Jira Link	Assignee	Status	Priority	Test Cases
LVV-183	Leanne Guy	Covered	2	LVV-T192

Verification Element Description:

At Base Facility, connect to WiFi, test connection speed, i.e. send email, browse web, and retrieve files from the Internet.

Upstream Requirements	
Requirement ID	DMS-REQ-0352
Requirement Description	**Specification:** The Base LAN shall provide **minBaseWiFi** Wireless LAN (WiFi) and Wireless Access Points in the Base Facility to support connectivity of individual user's computers to the network backbones.
Requirement Parameters	**minBaseWifi = 1000[megabit per second]** Maximum allowable outage of active DM production.
Requirement Priority	2
Upper Level Requirement	OSS-REQ-0003 The Base Facility

2.15.1 [LVV-T192] Verify implementation of Base Wireless LAN (WiFi)

Test Case Summary					
Jira Link	Owner	Status	Version	Critical Event	Verification Type
LVV-T192	Jeff Kantor	Draft	1	false	Test

Objective:

Verify as-built wireless network at the Base Facility supports minBaseWiFi bandwidth (1000 Mbs).

Precondition:

1. Base Wireless LAN is installed/configured and Test Personnel have accounts for email, internet access.

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2. As-built documentation for all of the above is available.

Predecessors:

PMCS DLP-465 Complete.

Test Personnel:

Heinrich Reinking (LSST)

2.16 [LVV-18491] DMS-REQ-0352-V-02: Base Voice Over IP (VOIP)

Jira Link	Assignee	Status	Priority	Test Cases
LVV-18491	Leanne Guy	Covered	2	LVV-T181

Verification Element Description:

Verify (a) plannned and (b) as-built VOIP at the Base Facility is operational and performs as expected (i.e. sufficient number of extensions allocated properly, no frequent drop-outs, no frequent jaggies on video, etc.). Test voice calls and videoconferening.

Upstream Requirements	
Requirement ID	DMS-REQ-0352
Requirement Description	**Specification:** The Base LAN shall provide **minBaseWiFi** Wireless LAN (WiFi) and Wireless Access Points in the Base Facility to support connectivity of individual user's computers to the network backbones.
Requirement Parameters	**minBaseWifi = 1000[megabit per second]** Maximum allowable outage of active DM production.
Requirement Priority	2
Upper Level Requirement	OSS-REQ-0003 The Base Facility

2.16.1 [LVV-T181] Verify Base Voice Over IP (VOIP)

Test Case Summary					
Jira Link	Owner	Status	Version	Critical Event	Verification Type
LVV-T181	Jeff Kantor	Draft	1	false	Test

Objective:

Verify as-built VOIP at the Base Facility is operational and performs as expected (i.e. sufficient number of extensions allocated properly, no frequent drop-outs, no frequent jaggies on video, etc.) on both voice calls and videoconferening.

Precondition:

1. Base VOIP is installed/configured and Test Personnel have phone sets. Base Videoconference system is installed/configured. Summit, Headquarters, and/or LDF Videoconference system is installed/configured.
2. As-built documentation for all of the above is available.

Predecessors:

PMCS DLP-465 Complete

PMCS IT-702 Complete

Test Personnel:

Heinrich Reinking (LSST), another LSST DM Person at Summit, Headquarters, or LDF

A   Traceability

Requirements	Verification Elements	Test Cases
DMS-REQ-0168	LVV-71(Gregory Dubois-Felsmann)	LVV-T1097 (Jeff Kantor)
		LVV-T2338 (Simon Krughoff)
DMS-REQ-0171	LVV-73(Leanne Guy)	LVV-T1168 (Jeff Kantor)
		LVV-T1612 (Jeff Kantor)
DMS-REQ-0172	LVV-74(Leanne Guy)	LVV-T185 (Jeff Kantor)
DMS-REQ-0173	LVV-75(Leanne Guy)	LVV-T186 (Jeff Kantor)
DMS-REQ-0174	LVV-76(Leanne Guy)	LVV-T187 (Jeff Kantor)
DMS-REQ-0175	LVV-77(Leanne Guy)	LVV-T188 (Jeff Kantor)
DMS-REQ-0180	LVV-81(Leanne Guy)	LVV-T193 (Jeff Kantor)
DMS-REQ-0181	LVV-82(Leanne Guy)	LVV-T194 (Jeff Kantor)
DMS-REQ-0182	LVV-83(Leanne Guy)	LVV-T195 (Jeff Kantor)
DMS-REQ-0183	LVV-84(Leanne Guy)	LVV-T196 (Jeff Kantor)
DMS-REQ-0188	LVV-88(Leanne Guy)	LVV-T200 (Jeff Kantor)
DMS-REQ-0189	LVV-89(Leanne Guy)	LVV-T201 (Jeff Kantor)
DMS-REQ-0190	LVV-90(Leanne Guy)	LVV-T202 (Jeff Kantor)
DMS-REQ-0191	LVV-91(Leanne Guy)	LVV-T203 (Kian-Tat Lim)
DMS-REQ-0352	LVV-183(Leanne Guy)	LVV-T192 (Jeff Kantor)
	LVV-18491(Leanne Guy)	LVV-T181 (Jeff Kantor)

B   References

[1] **[LSE-61]**, Dubois-Felsmann, G., Jenness, T., 2019, *Data Management System (DMS) Requirements*, LSE-61, URL `https://lse-61.lsst.io/`

[2] **[LDM-142]**, Kantor, J., 2017, *Network Sizing Model*, LDM-142, URL `https://ls.st/LDM-142`

[3] **[LSE-78]**, Lambert, R., Kantor, J., Huffer, M., et al., 2017, *LSST Observatory Network Design*, LSE-78, URL `https://ls.st/LSE-78`

[4] **[LSE-160]**, Selvy, B., 2013, *Verification and Validation Process*, LSE-160, URL `https://ls.st/LSE-160`

C Acronyms

Acronym	Description
BDC	Base Data Center
BERT	Bit Error Rate Tester
CCB	Change Control Board
CCS	Camera Control System
CISS	Computer Infrastructure Services South (part of the former NOAO Cerro Tololo Inter-american Observatory (CTIO), now merged into NSF'S OIR Lab Central Operating Services)
CTIO	Cerro Tololo Inter-American Observatory
DAC	Data Access Center
DAQ	Data Acquisition System
DM	Data Management
DMCS	Data Management Control System
DMS	Data Management Subsystem
DMS-REQ	Data Management top level requirements (LSE-61)
DMSR	DM System Requirements; LSE-61
DMSSIT	DM Subsystem Integration Test
DMTN	DM Technical Note
DMTR	DM Test (Plan and) Report
DTN	Data Transfer Node
DWDM	Dense Wave Division Multiplex
Db	Decibel
EFD	Engineering and Facility Database
EPO	Education and Public Outreach
FIU	Florida International University
HL	Higher Level
IP	Internet Protocol
IRU	indefinable right to use
ISO	International Standards Organization
IT	Information Technology
LAN	Local Area Network
LATISS	LSST Atmospheric Transmission Imager and Slitless Spectrograph
LDF	LSST Data Facility

LDM	LSST Data Management (Document Handle)
LHN	Long-Haul Networks
LL	Lower Level
LS	La Serena
LSE	LSST Systems Engineering (Document Handle)
LSST	Legacy Survey of Space and Time (formerly Large Synoptic Survey Telescope)
LVV	LSST Verification and Validation (Jira project)
MTBF	Mean Time Between Failures
MTTR	Mean Time to Repair
NA	Not Available
NCSA	National Center for Supercomputing Applications
NET	Network Engineering Team
OCS	Observatory Control System
OSI	Open System Interconnect
OSS	Observatory System Specifications; LSE-30
OTDR	Optical Time Domain Reflectometer
PMCS	Project Management Controls System
REUNA	Red Universitaria Nacional
RFC	Request For Comment
SC	Science Collaboration
SCL	Santiago, Chile
SIT	LSST System Integration Test
SL	Same Level
SLAC	SLAC National Accelerator Lab
TCS	Telescope Control System
US	United States
VNVD	Vera C Rubin Observatory Network Verification Document
VOIP	Voice Over Internet Protocol
WBS	Work Breakdown Structure