



LARGE SYNOPTIC SURVEY TELESCOPE

Large Synoptic Survey Telescope (LSST)
Data Management

LDM-503-10a: LSP with Authentication and TAP Test Plan and Report

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DMTR-161

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Abstract

This is the test plan and report for LDM-503-10a: (LSP with Authentication and TAP), an LSST level 2 milestone pertaining to the Data Management Subsystem.

Change Record

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	2019-09-09	First Draft	G. Dubois-Felsmann
0.1	2019-11-18	LVV-P48 approved in DM-19211, ticket branch merged to master	G. Dubois-Felsmann
1.0	2020-01-14	LVV-P48 Completed. Test Campaign reviewed and approved in DM-19209	G. Dubois-Felsmann

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LDM-503-10a: LSP with Authentication and TAP Test Plan and Report

1 Introduction

1.1 Objectives

Verify the integration of federated authentication and authorization into the LSST science platform, and the availability of an IVOA TAP service.

Milestone Description

This test demonstrates the successful integration of a single-sign-on federated authentication system, and a basic authorization system, with the three Aspects of the LSST Science Platform (Portal, Notebook, and API), with the API Aspect containing at least a TAP service. It will be demonstrated on a Kubernetes cluster provided by NCSA. It is not required for authorization to be applied at the database level; it is sufficient for this milestone for it to apply only at the TAP level. Data served will remain that from the original PDAC work, i.e., SDSS Stripe 82 and/or WISE.

1.2 Scope

The overall strategy for testing and verification within LSST Data Management is described in LDM-503.

This test plan specifically verifies successful completion of milestone LDM-503-10a.

1.3 System Overview

The LSST Science Platform (see LSE-319, LDM-554, and LDM-542) is the means of access for science users to the LSST data. It also serves project-internal users for a wide variety of data access needs during construction (using prototypes and early versions), commissioning, and operations.

1.4 Document Overview

This document was generated from Jira, obtaining the relevant information from the LVV-P48 Jira Test Plan and related Test Cycles (LVV-C85).

Section 1 provides an overview of the test campaign, the system under test (LSP Services), the applicable documentation, and explains how this document is organized. Section 2 describes the configuration used for this test. Section 3 describes the necessary roles and lists the individuals assigned to them. including all relevant information that fully describes the test campaign.

Section 4 provides a summary of the test results, including an overview in Table 2, an overall assessment statement and suggestions for possible improvements. Section 5 provides detailed results for each step in each test case.

The current status of test plan LVV-P48 in Jira is **Completed** .

1.5 References

- [1] **[LDM-542]**, Dubois-Felsmann, G., Lim, K.T., Wu, X., et al., 2017, *LSST Science Platform Design*, LDM-542, URL <https://ls.st/LDM-542>
- [2] **[LDM-554]**, Dubois-Felsmann, G., Ciardi, D., Mueller, F., Economou, F., 2018, *Science Platform Requirements*, LDM-554, URL <https://ls.st/LDM-554>
- [3] **[LSE-319]**, Jurić, M., Ciardi, D., Dubois-Felsmann, G., 2017, *LSST Science Platform Vision Document*, LSE-319, URL <https://ls.st/LSE-319>

[4] **[LDM-503]**, O'Mullane, W., Swinbank, J., Jurić, M., Economou, F., 2018, *Data Management Test Plan*, LDM-503, URL <https://ls.st/LDM-503>

2 Test Configuration

2.1 Data Collection

Observing is not required for this test campaign.

2.2 Verification Environment

The "lsst-lsp-stable" instance of the LSP, hosted at the LDF.

3 Personnel

The personnel involved in the test campaign are shown in the following table.

Test Plan (LVV-P48) owner:		Gregory Dubois-Felsmann	
LVV-C85 owner:		Gregory Dubois-Felsmann	
Test Case	Assigned to	Executed by	Additional Test Personnel
LVV-T807	Jeffrey Carlin	Gregory Dubois-Felsmann	
LVV-T622	Jeffrey Carlin	Gregory Dubois-Felsmann	
LVV-T1334	Gregory Dubois-Felsmann	Gregory Dubois-Felsmann	
LVV-T1436	Gregory Dubois-Felsmann	Gregory Dubois-Felsmann	
LVV-T1437	Gregory Dubois-Felsmann	Gregory Dubois-Felsmann	

4 Test Campaign Overview

4.1 Summary

Test Plan LVV-P48: LDM-503-10a: LSP with Authentication and TAP			Completed
Test Cycle LVV-C85: LDM-503-10a: LSP with Authentication and TAP			Done
test case	status	comment	issues
LVV-T807	Pass	Test executed against lsst-lsp-int. No problems were encountered.	
LVV-T622	Pass w/ Deviation	Test executed against lsst-lsp-int. Minor concerns with the UX for logout operations, and with the completeness of the result of logging out.	DM-22338 DM-22350
LVV-T1334	Pass w/ Deviation	Test executed in full against lsst-lsp-int. As preparation for the execution of LVV-T1436 and LVV-T1437, Steps 6 and 9 were repeated several days later against lsst-lsp-stable in order to refresh the TAP-results URL needed for the subsequent tests. Minor deviations: certain WISE/NEOWISE single-epoch photometry tables, not needed for the test, were not visible in the TAP service; same concerns with logout behavior as for LVV-T622.	DM-22350 DM-22421 DM-22422
LVV-T1436	Pass w/ Deviation	Test executed against lsst-lsp-stable. No concerns except the same minor issues with logout behavior reported for LVV-T622.	DM-22350
LVV-T1437	Pass w/ Deviation	Test executed against lsst-lsp-stable. Minor concern: lack of usability of the latest version of the LSST "convenience API" for TAP service access from offsite; fixed by reverting to an earlier version.	DM-22538

Table 2: Test Campaign Summary

4.2 Overall Assessment

The test successfully demonstrated cross-Aspect single-sign-on and the federated-identity functionality, as well as demonstrating authenticated access to synchronous and asynchronous TAP queries from the Portal Aspect, Notebook Aspect, and from outside the LSST environment acting directly on the API Aspect. The test demonstrated the ability to perform a TAP query in the Portal Aspect and retrieve the results from the Notebook Aspect, or remotely, by means of the query URL obtained from the Portal UI.

Minor issues were observed in the following areas:

1. "Logout" functionality was not particularly user-friendly, and in some cases may not have performed a complete logout
2. The CILogon federated-ID-authentication service may in some cases allow a user to determine whether a userid string is valid at NCSA even without a password
3. The existing set of tables in Qserv were not organized or described as well in the API Aspect TAP service's TAP_SCHEMA interface, and therefore also not in the Portal Aspect UI - however these were corrected immediately following the test under DM-22422
4. The WISE (including NEOWISE) single-epoch photometry tables were not visible in the TAP service - this has been understood and will be addressed
5. The most recent version of the Python "convenience API" for TAP searches in the "jupyterlabutils" package became unusable for external queries because of an issue with token validation. A previous version supported the test successfully, and the path forward for this API will be discussed.

4.3 Recommended Improvements

The most salient UX improvement based on this testing would be to change the "logout" functionality in both the Notebook and Portal Aspects to return the user to the LSP landing page, or some other recognizable page, as well as to add to the landing page an indication of whether the user is logged in or not.

Ongoing attention to the quality of the information in TAP_SCHEMA would be highly desirable.



This is more of a science-support issue than a TAP-service-development issue.

Some thought should be given to what support code, examples, and documentation should be provided for external users of the TAP service (and other API Aspect services as they become available).

5 Detailed Test Results

5.1 Test Cycle LVV-C85

Open test cycle *LDM-503-10a: LSP with Authentication and TAP* in Jira.

LDM-503-10a: LSP with Authentication and TAP

Status: Done

Execute the test cases associated with the DM milestone LDM-503-10a.

5.1.1 Software Version/Baseline

Portal Aspect tests were carried out on `suit:1.1.1` and `Caltech-IPAC/firefly:release-2019.3.2`.

The LSST Python environment in the Notebook Aspect was based on `weekly 2019_48`, including `JupyterLab v1.2.3`.

LSST JupyterHub version `sciplat-hub-with-config:0.16.7` was in operation in the instance under test.

TAP version 1.0.1 was the version under test.

5.1.2 Configuration

LVV-T807, LVV-T637, and LVV-T1334 were carried on out the `lsst-lsp-int` instance of the LSP because of maintenance issues with the Portal Aspect on `lsst-lsp-stable`.

Following the return to normal operation of `lsst-lsp-stable`, part of LVV-T1334 was repeated there, and LVV-T1436 and LVV-T1437 were executed there.

All tests were executed from an OS X 10.11.6 iMac host on the IPAC internal network, with prearranged VPN-free access to the LSP instances at NCSA. Tests requiring a web browser were carried out using Firefox 70.0.1.

5.1.3 Test Cases in LVV-C85 Test Cycle

5.1.3.1 Test Case LVV-T807 - Verify synchronous TAP queries

Open *LVV-T807* test case in Jira.

Verify that the API Aspect TAP endpoint supports synchronous queries as described by the IVOA TAP 1.1 specification.

Preconditions:

Execution status: **Pass**

Final comment:

Test executed against lsst-lsp-int.

No problems were encountered.

Detailed steps results:

Step	Step Details
1	<p>Description</p> <p>Using a Web browser, navigate to the "/auth/tokens" endpoint of the LSP instance under test.</p> <hr style="border-top: 1px dashed #000;"/> <p>Expected Result</p> <p>A credential-entry screen should be displayed, unless the test user is already logged in in another window or tab of the browser.</p> <hr style="border-top: 1px dashed #000;"/> <p>Actual Result</p> <p>The general CILogon login screen appeared.</p> <hr style="border-top: 1px dashed #000;"/> <p>Status: Pass</p>
2	<p>Description</p> <p>If necessary, enter a valid set of credentials. They may be NCSA or non-NCSA credentials.</p> <hr style="border-top: 1px dashed #000;"/> <p>Expected Result</p> <p>The token-request UI is displayed.</p> <hr style="border-top: 1px dashed #000;"/> <p>Actual Result</p>

NCSA credentials were used, with a Duo push. Successful; reached "Personal access tokens" screen.

Status: **Pass**

3 Description

Request a token for the "read:tap" capability.

Expected Result

A screen confirming the creation of the token.

Actual Result

"Generate new token" selected. "read:tap" selected.

A token oauth2_proxy-a77...6b9b generated, expiring in 24 hours.

Status: **Pass**

4 Description

Leave the resulting page's browser tab/window open for use in subsequent test steps.

In many cases you may be asked in a subsequent step to use the "copy token to clipboard" UI element on this page in order to transfer your token to a prompt in another window.

Expected Result

Actual Result

(n/a)

Status: **Pass**

5 Description

From a Unix prompt on a system with network access to the TAP service in the LSP instance under test, and a "bash"-style shell, verify using the "export" and "curl" commands below that an attempt to access the TAP service with the token from the previous step is successful.

Replace "lsst-lsp-int.ncsa.illinois.edu" in the "curl" command with the appropriate root URL for the LSP instance under test.

Use the "copy to clipboard" function from the token-access page from the previous step to paste the token into the (blind) prompt that results from the "read" command.

Ensure that the token is deleted from the test environment after the "curl" command is complete, and that the token is invalidated via the token-access web interface.

Example Code

```
export ACCESS_TOKEN
read -p token -s ACCESS_TOKEN
curl -w 'HTTP status code:   %{http_code}\nContent-Type:   %{content_type}\nTotal time:
%{time_total}\nBytes received:   %{size_download}\nFinal URL:   %{url_effective}\n' -L -
header "Authorization:   Bearer   ${ACCESS_TOKEN}" -o tap-tables.xml 'https://lsst-lsp-
int.ncsa.illinois.edu/api/tap/sync?LANG=ADQL&REQUEST=doQuery&QUERY=SELECT+*+FROM+TAP_SCHEMA.tables'
unset ACCESS_TOKEN
```

Expected Result

Actual Result

The “curl” command returned HTTP status code 200, in a total time 1.081s, returning 8391 bytes with Content-Type “application/x-votable+xml”. The file tap-tables.xml was created and is attached to this execution.

Status: **Pass**

6 Description

Verify by inspection that the file resulting from the “curl” command above has the general form of a VOTable. (A separate test case will verify the VOTable format itself.)

Save this file as part of the test records using LSST standard procedures.

Expected Result

Actual Result

The tap-tables.xml file does appear to the eye to be a reasonably conformant VOTable 1.3 file with a TABLEDATA payload.

Status: **Pass**

5.1.3.2 Test Case LVV-T622 - Verify LSP only available to authenticated users

Open *LVV-T622* test case in Jira.

Verify that the functions and services of all three aspects of the LSP are accessible only to authenticated users.

Preconditions:

Execution status: **Pass w/ Deviation**

Final comment:

Test executed against lsst-lsp-int.

Minor concerns with the UX for logout operations, and with the completeness of the result of logging out.

Detailed steps results:

Step	Step Details
1	<p>Description</p> <p>Attempt to navigate to the Portal Aspect of the LSP instance under test. Verify that credentials are requested and that a Portal interface is not displayed.</p> <hr/> <p>Expected Result</p> <p>No direct access to Portal; credential request screen displayed.</p> <hr/> <p>Actual Result</p> <p>Confirmed; CILogon with an LSST facade was reached. "LSST LSP Integration (Domain Ingress Client) requests access to the following information. If you do not approve this request, do not proceed."</p> <hr/> <p>Status: Pass</p>
2	<p>Description</p> <p>Enter the (presumably invalid) credentials user=foo, password=xyzy, and verify that access to the Portal Aspect interface is not granted.</p> <hr/> <p>Test Data</p> <p>user=foo, password=xyzy</p> <hr/> <p>Expected Result</p> <p>No access to Portal Aspect; credential request screen displayed again. Record any error message that is shown.</p> <hr/> <p>Actual Result</p> <p>The message "The username you entered cannot be identified." was displayed in a colored box on the CILogon login screen. This is worth further investigation, to see whether this allows external actors to deduce valid userids.</p> <hr/> <p>Issues found executing this step:</p> <p>DM-22338 CILogon can be used to check whether an NCSA username is valid; is this OK?</p> <hr/> <p>Status: Pass</p>
3	<p>Description</p>

Enter a set of valid credentials, and verify that access to the Portal interface is granted.

This test does not involve any exploration of the Portal behavior at this point.

Test Data

Credentials for the user executing the test.

Expected Result

Access to some version of the Portal interface is granted. (The exact nature of that interface will be evolving in the course of LSST construction and system integration.)

Actual Result

The "TAP Searches" screen of the Portal application appeared by default.

Status: **Pass**

4 Description

Log out from the Portal.

Expected Result

A logout or LSP landing page is displayed.

Actual Result

A screen with just a "Sign in with OpenID Connect" button (and a footer reading "Secured with OAuth2 Proxy version v3.2.0-151-g151ec7b") appeared.

This is not entirely acceptable in the long run. The user should never lose sight of a screen that confirms that they are still in an LSST environment. It is also not clear to what authentication domain one would be signing in, or what screen one would reach if signing in were successful.

Issues found executing this step:

DM-22350 "Logout" buttons in Portal and Notebook Aspects: non-user-friendly result, and apparently incomplete logout

Status: **Initial Pass**

5 Description

Attempt to navigate to the Notebook Aspect of the LSP instance under test. Verify that credentials are requested and that no other Notebook Aspect functionality is exposed.

Expected Result

No direct access to the Notebook Aspect; credential request screen displayed.

Actual Result

Manual navigation back to the main instance landing page was required. No link to do this was available from the screen displayed in Step 4.

Once at the landing page, clicking on the "Notebook Aspect" link produced a fresh CILogon login screen.

Status: **Pass**

6 Description

Enter the (presumably invalid) credentials user=foo, password=xyzy, and verify that access to the Notebook Aspect interface is not granted.

Test Data

user=foo, password=xyzy

Expected Result

No access to Notebook Aspect; credential request screen displayed again. Record any error message that is shown.

Actual Result

After pressing the "Log On" button on the initial CILogon screen, it became clear that I had not in fact been fully logged out. No username/password screen was displayed at all, and I ended up on the "Start My Server" page of JupyterHub, with my userid displayed and a "Logout" button. Clicking that "Logout" button was no more successful at actually logging me out than the Portal equivalent was.

Conditional pass because the security vulnerability here only seriously affects shared-browser situations.

Status: **Pass w/ Deviation**

7 Description

Enter a set of valid credentials, and verify that access to the Notebook Aspect interface is granted.

This test does not involve any exploration of the Notebook Aspect behavior at this point.

Test Data

Credentials for the user executing the test.

Expected Result

An initial page of the JupyterHub system is displayed. Note briefly what is seen, but no further testing is required.

Actual Result

This step also could not be executed, as it proved impossible to get the system into a state in which credentials were requested.

Status: **Pass w/ Deviation**

8 Description

Log out of the Notebook Aspect.

Expected Result

Actual Result

This had the same result as in Step 4.

Status: **Initial Pass**

9 Description

From a Unix prompt on a system with network access to the TAP service in the LSP instance under test, verify using the “curl” command below that an attempt to access the TAP service without credentials is rejected.

Expected Result

Actual Result

(Step 9 appears to have been an incomplete duplicate of Step 10. Skipped.)

Status: **Pass**

10 Description

From a Unix prompt on a system with network access to the TAP service in the LSP instance under test, verify using the “curl” command below that an attempt to access the TAP service with invalid credentials is rejected.

Replace “lsst-lsp-int.ncsa.illinois.edu” in the “curl” command with the appropriate root URL for the LSP instance under test.

Example Code

```
curl -w 'HTTP status code:   %{http_code}\nContent-Type:   %{content_type}\nTotal time:   %{time_total}\nBytes received:   %{size_download}\nFinal URL:   %{url_effective}\n' -L 'https://lsst-lsp-int.ncsa.illinois.edu/api/tap/sync?LANG=ADQL&REQUEST=doQuery&QUERY=SELECT+*+FROM+TAP_SCHEMA.tables'
```

Expected Result

Actual Result

HTTP status code 401 (Authorization Required) was received. The HTML code attached as “tap-noauth.html” was returned.

Status: **Pass**

11 Description

Using a web browser, navigate to the token-access endpoint (/auth/tokens) of the LSP instance under test. Authenticate with valid LSST credentials. Obtain a token for the “read:tap” capability. Leave the resulting web page displayed. It is not necessary to expose the full token text.

Expected Result

A token is granted.

Actual Result

Token ID oauth2_proxy-c077...00f8 was received, with a 24 hour lifetime.

Status: **Pass**

12 Description

From a Unix prompt on a system with network access to the TAP service in the LSP instance under test, and a “bash”-style shell, verify using the “export” and “curl” commands below that an attempt to access the TAP service with the token from the previous step is successful.

Replace “lsst-lsp-int.ncsa.illinois.edu” in the “curl” command with the appropriate root URL for the LSP instance under test.

Use the “copy to clipboard” function from the token-access page from the previous step to paste the token into the (blind) prompt that results from the first “export” command.

Ensure that the token is deleted from the test environment after the “curl” command is complete, and that the token is invalidated via the token-access web interface.

----- Example Code

```
export ACCESS_TOKEN
read -p token -s ACCESS_TOKEN
curl -w 'HTTP status code:   %{http_code}\nContent-Type:   %{content_type}\nTotal time:
%{time_total}\nBytes received:   %{size_download}\nFinal URL:   %{url_effective}\n' -L -
header "Authorization:   Bearer   ${ACCESS_TOKEN}" -o tap-tables.xml 'https://lsst-lsp-
int.ncsa.illinois.edu/api/tap/sync?LANG=ADQL&REQUEST=doQuery&QUERY=SELECT+*+FROM+TAP_SCHEMA.tables'
unset ACCESS_TOKEN
```

----- Expected Result

The “curl” command should return HTTP status code 200 and a VOTable containing a list of tables in the TAP service should be obtained.

Retain the VOTable file in the test records.

----- Actual Result

The test was successful.

Status: **Pass**

5.1.3.3 Test Case LVV-T1334 - LDM-503-10a: Portal Aspect tests for LSP with Authentication and TAP milestone

Open *LW-T1334* test case in Jira.

This test case verifies that the Portal Aspect of the Science Platform is accessible to authorized users through a login process, and that TAP searches can be performed from the Portal Aspect UI.

In so doing and in conjunction with the other LDM-503-10a test cases collected under LWV-P48, it addresses all or part of the following requirements:

- DMS-LSP-REQ-0002, DMS-LSP-REQ-0005, DMS-LSP-REQ-0006, DMS-LSP-REQ-0020, DMS-LSP-REQ-0022, DMS-LSP-REQ-0023, DMS-LSP-REQ-0024
- DMS-PRTL-REQ-0001, DMS-PRTL-REQ-0015, DMS-PRTL-REQ-0016, DMS-PRTL-REQ-0017, DMS-PRTL-REQ-0020, DMS-PRTL-REQ-0026, DMS-PRTL-REQ-0049, and DMS-PRTL-REQ-0095, primarily

Note this test was not designed to perform a full verification of the above requirements, but rather to demonstrate having reached a certain level of partial capability during construction.

Preconditions:

Execution status: **Pass w/ Deviation**

Final comment:

Test executed in full against *lsst-lsp-int*.

As preparation for the execution of *LWV-T1436* and *LWV-T1437*, Steps 6 and 9 were repeated several days later against *lsst-lsp-stable* in order to refresh the TAP-results URL needed for the subsequent tests.

Minor deviations: certain WISE/NEOWISE single-epoch photometry tables, not needed for the test, were not visible in the TAP service; same concerns with logout behavior as for *LWV-T622*.

Detailed steps results:

Step	Step Details
1	<p data-bbox="313 327 467 357">Description</p> <p data-bbox="313 375 1445 441">Navigate to the https://lsst-lsp-stable.ncsa.illinois.edu/ endpoint of the LSP at the LDF. From the displayed page, navigate to the Portal Aspect.</p> <hr/> <p data-bbox="313 464 440 493">Test Data</p> <p data-bbox="313 512 350 537">n/a</p> <hr/> <p data-bbox="313 556 529 585">Expected Result</p> <p data-bbox="313 604 703 634">A login screen should be displayed.</p> <hr/> <p data-bbox="313 653 488 682">Actual Result</p> <p data-bbox="313 701 911 730">Test performed on https://lsst-lsp-int.ncsa.illinois.edu/</p> <p data-bbox="313 810 711 840">Login screen displayed as expected.</p> <hr/> <p data-bbox="313 858 488 888">Status: Pass</p>
2	<p data-bbox="313 909 467 938">Description</p> <p data-bbox="313 957 1445 1022">Log in to the Portal Aspect with NCSA credentials. Verify that a Portal TAP search screen comes up. Note the user name displayed in the upper left of the Portal. Log out.</p> <hr/> <p data-bbox="313 1041 440 1071">Test Data</p> <p data-bbox="313 1089 769 1119">(NCSA credentials for an authorized user)</p> <hr/> <p data-bbox="313 1138 529 1167">Expected Result</p> <p data-bbox="313 1186 1445 1287">Following login, the Portal Aspect TAP search screen should be displayed, or a clearly visible UI element allowing one-click access to that screen. A user name corresponding to the credentials entered should be displayed.</p> <hr/> <p data-bbox="313 1306 488 1335">Actual Result</p> <p data-bbox="313 1354 1317 1383">TAP search screen displayed upon login. Username "Gregory Dubois-Felsmann" displayed.</p> <p data-bbox="313 1463 1445 1528">Logging out resulted in the "Sign in with OpenID Connect" button being displayed. See DM-22350 for an issue regarding that result.</p> <hr/> <p data-bbox="313 1547 751 1577">Issues found executing this step:</p> <p data-bbox="313 1596 1289 1661">DM-22350 "Logout" buttons in Portal and Notebook Aspects: non-user-friendly result, and apparently incomplete logout</p> <hr/> <p data-bbox="313 1680 488 1709">Status: Pass</p>
3	<p data-bbox="313 1728 467 1757">Description</p> <p data-bbox="313 1776 1365 1806">Log in to the Portal Aspect with alternate credentials that are associated with the same identity.</p> <hr/> <p data-bbox="313 1824 529 1854">Expected Result</p>

The Portal application should come up just as in the previous step; the user name displayed in the upper left of the Portal should be the same as in the previous step.

Actual Result

Because of the logout issues in DM-22350, before carrying out this step I cleared my browser history to ensure no carryover of old credentials/tokens/authorization headers.

Logging in with Caltech credentials that had been associated with my NCSA account via identity.lsst.org, I reached the same Portal screen with “Gregory Dubois-Felsmann” displayed.

Status: **Pass**

4 Description

Navigate to the TAP search screen, if necessary, and ensure that the LSST TAP service associated with the chosen LSP instance is selected.

Expected Result

A TAP search screen should either already be displayed after the previous step, or should be displayed after a one-click action from the Portal’s initial page. On the TAP screen, a UI element allowing the choice of TAP service to user should be available, and an LSST TAP service associated with the LSP instance under test should be pre-selected as the default.

Actual Result

The lsst-lsp-int.ncsa.illinois.edu/api/tap service was, correctly, selected by default.

Status: **Pass**

5 Description

Verify that the same WISE and SDSS catalog tables that were explored in DMTR-52 are now visible in the TAP service.

Expected Result

The SDSS Stripe 82 2013 processing’s deep detection and forced photometry catalogs, and the WISE mission’s principal catalog, forced photometry catalog, and single-epoch source catalog should be accessible.

Actual Result

The SDSS “RunDeepSource” (deep detection) and “RunDeepForcedSource” (forced photometry) tables are available, under the “sdss_stripe82_01” schema (along with a number of additional tables from the original deployment).

The WISE “allwise_p3as_psd” (deep detection) and “allwise_p3as_mep” (forced photometry) tables are available, under the “wise_00” schema (along with a number of additional tables from the original deployment). The three single-epoch source photometry tables do not seem to be visible.

While this is not formally a deviation from the test plan as written, these tables are all missing explanatory text in the TAP_SCHEMA metadata used by the Portal TAP interface, so there is no user-friendly way to determine the meaning of the tables available to query.

Issues found executing this step:

DM-22421 Investigate why the WISE single-epoch photometry tables are not visible in the Isst-lsp-int TAP service

DM-22422 Provide metadata for the SDSS and WISE schema and table data in TAP_SCHEMA

Status: **Pass w/ Deviation**

6 Description

Perform a TAP search on the AllWISE source catalog around the equatorial coordinates (2, 0) (degrees), with a 30 arcminute radius, using the Portal UI to specify the query (select the “Single Table” radio button).

To find the AllWISE source catalog, select the “wise_00” schema from the schema menu, and then the “wise_00.allwise_p3as_psd” table from the table menu.

When the query completes, note the total number of rows in the table, as displayed in the table header, and record it.

Test Data

Equatorial coordinates: (2, 0), cone radius 30 arcmin

Expected Result

This query should return about 12,000 rows of data. It should be displayed in a table, as an overlay on a context image, and as a configurable 2D density plot.

Actual Result

A table of 12,717 rows was retrieved. The data were displayed as a table of 128 100-row pages (that default page size is configurable, and can be changed on the fly by the user). They were also displayed as an overlay on a 2MASS color HiPS image, and as an x-y density plot, with the axes (ra,decl) selected by default, but easily changed in the UI.

The test runner issued the query requesting the following columns (which should have been called out in the test specification): ra, decl, cntr, source_id, coadd_id, w1mpro, w2mpro, w3mpro, w4mpro.

Status: **Pass**

7 Description

Using the table viewer UI, save the result of this search as a text file in CSV format. Use a line-counting tool to find the number of rows in the result, record it, and compare it with the reported number from the previous step. Ensure that the CSV file's name is "LVV-T1334-output.csv" and save it to the designated repository for test outputs.

Expected Result

Allowing for the CSV header row, the number of rows in the file should match the number of rows in the table header in the UI.

Actual Result

```
% wc LVV-T1334-output.csv
12718 12718 1567903 LVV-T1334-output.csv
% head -2 LVV-T1334-output.csv
cntr,coadd_id,decl,ra,source_id,w1mpro,w2mpro,w3mpro,w4mpro
15100001351031627,0015p000_ac51,-0.07016340,1.54437160,0015p000_ac51-
031627,16.36700000,15.81700000,12.21100000,8.40600000
```

12,718 rows in the file is the expectation from Step 6: 12,717 plus one header row.

The file was attached to the test execution record in Jira (LVV-E556).

The file was also saved in the lsst-dm/dmtr-161 repository as "executions/LVV-T1334/LVV-T1334-output.csv". Tag "LVV-T1334-e1" was applied.

Status: **Pass**

8 Description

Return to the TAP search screen in the UI (this can be done with the "TAP Searches" button near the top of the window), select the "ADQL" radio button, and view and record the ADQL text displayed for the query performed. Select "Cancel" to dismiss the search screen.

Expected Result

The query should appear to have the expected form for an ADQL cone search, using the CONTAINS() and CIRCLE() functions.

Actual Result

The button is labeled “LSST TAP”, not “TAP Searches”.

The ADQL text is:

```
SELECT          cntr,coadd_id,decl,ra,source_id,w1mpro,w2mpro,w3mpro,w4mpro          FROM
wise_00.allwise_p3as_psd WHERE CONTAINS(POINT('ICRS', ra, decl),CIRCLE('ICRS', 2, 0, 0.5))=1
```

Status: **Pass**

9 Description

Select the “i”-in-a-circle button in the table header. In the resulting dialog box, click on the copy-to-clipboard icon for the TAP job URL for the query and paste the URL into the test record.

Expected Result

Actual Result

<https://lsst-lsp-int.ncsa.illinois.edu/api/tap/async/eatzseuepds92ous>

Status: **Pass**

10 Description

In a separate browser window, access the page available at the URL obtained from the previous step. Observe and record the ADQL text for the query, in the ‘<uws:parameter id=“query”>’ XML element. Verify that it matches the ADQL text obtained from the UI in a previous step.

Expected Result

The ADQL code matches that from Step 8.

Actual Result

Pass:

<uws:parameter id=“QUERY”>

```
SELECT          cntr,coadd_id,decl,ra,source_id,w1mpro,w2mpro,w3mpro,w4mpro          FROM
wise_00.allwise_p3as_psd WHERE CONTAINS(POINT('ICRS', ra, decl),CIRCLE('ICRS', 2, 0, 0.5))=1
```

</uws:parameter>

Status: **Pass**

5.1.3.4 Test Case LVV-T1436 - LDM-503-10a: Notebook Aspect tests for LSP with Authentication and TAP milestone

Open *LW-T1436* test case in Jira.

This test case verifies that the Notebook Aspect of the Science Platform is accessible to au-

thorized users through a login process, and that TAP searches can be performed from Python code in the Notebook Aspect.

In so doing and in conjunction with the other LDM-503-10a test cases collected under LVV-P48, it addresses all or part of the following requirements:

- DMS-LSP-REQ-0003, DMS-LSP-REQ-0005, DMS-LSP-REQ-0006, DMS-LSP-REQ-0020, DMS-LSP-REQ-0022, DMS-LSP-REQ-0023, DMS-LSP-REQ-0024
- DMS-NB-REQ-0001, DMS-NB-REQ-0002, DMS-NB-REQ-0005, DMS-NB-REQ-0006, DMS-NB-REQ-0013, DMS-NB-REQ-0017, and DMS-NB-REQ-0029, primarily

Note this test was not designed to perform a full verification of the above requirements, but rather to demonstrate having reached a certain level of partial capability during construction.

Preconditions:

Test case LVV-T1334 must have already been executed and the prescribed outputs saved, notably including the “LVV-T1334-output.csv” file.

Execution status: **Pass w/ Deviation**

Final comment:

Test executed against lsst-lsp-stable.

No concerns except the same minor issues with logout behavior reported for LVV-T622.

Detailed steps results:

Step	Step Details
1	<p>Description</p> <p>If LVV-T1334 (1.0) has just been carried out, the tester will already be logged in to the Portal Aspect; skip to the next step.</p> <p>Otherwise, use a Web browser to navigate to the landing page of the LSP instance under test, and click through to the Portal Aspect link. This should trigger a login process; the tester should log in. Non-NCSA credentials should be used (or have been used) to log in to the Portal Aspect.</p> <hr/>

Expected Result

The web browser should display a Portal Aspect page with the user's name noted in the upper right hand corner.

Actual Result

Carried out on {{lsst-lsp-stable}}.

Caltech credentials used; "Gregory Dubois-Felsmann" displayed.

NB: to enable further testing, the UI-driven Portal TAP search from LVV-T1334 Step 6 was repeated in this session in order to refresh the TAP results URL needed below.

It is now <https://lsst-lsp-stable.ncsa.illinois.edu/api/tap/async/gbupxri6cznn4jt7> - replacing the one recorded in LVV-T1334's execution.

Status: **Pass**

2 Description

Use the same Web browser (in a new page or tab) to navigate to the landing page of the LSP instance under test, and click through to the Notebook Aspect link.

Expected Result

No login credentials should be requested. A page allowing the creation of a Notebook Aspect session should be visible.

Actual Result

No credentials were requested. "gpdf" was displayed as the user ID in the upper right.

Status: **Pass**

3 Description

Use the Notebook Aspect UI to create a "small" session using the most recent "recommended" (weekly) release image.

Expected Result

The main JupyterLab UI should appear.

Actual Result

The Weekly 2019_48 release was used. Successful session startup.

Status: **Pass**

4 Description

Close any Portal Aspect window/tab(s) that are open.

Expected Result

Actual Result

Status: **Pass**

5

Description

Use the JupyterLab Terminal application to create a small file in the user's home directory.

Example Code

To be executed in the Terminal at the shell prompt, e.g.:

```
touch ~/test-20190915.txt
```

(Use the current date.)

Expected Result

The test file should be visible in the JupyterLab file browser.

Actual Result

touch ~/20191209.txt was created.

Status: **Pass**

6

Description

Log out of the Notebook Aspect.

Expected Result

Actual Result

The "Sign in with OpenID Connect" screen was displayed. (As noted elsewhere this is not ultimately a user-friendly place for a logout to end up.)

Status: **Pass**

7

Description

Navigate to the landing page for the LSP instance under test. Navigate to the Portal Aspect from that page. (Do not log in if a login is requested.)

Expected Result

A login should be requested when the Portal Aspect is accessed. (This verifies that *logout* is cross-Aspect.)

Actual Result

The browser displayed a version of the Portal Aspect screen at first, with its Firefly components greyed out. It required an explicit refresh before the CILogon screen was displayed. Most likely some improvement to cache invalidation will be needed.

Issues found executing this step:

DM-22350 "Logout" buttons in Portal and Notebook Aspects: non-user-friendly result, and apparently incomplete logout

Status: **Pass w/ Deviation**

8

Description

Close the login window and quit the web browser in use.

Expected Result

Actual Result

Status: **Pass**

9 Description

Launch a web browser and navigate to the landing page for the LSP instance under test. Navigate to the Notebook Aspect. When prompted for a login, use NCSA credentials (for the same user as the non-NCSA credentials used above). Request a session of the “medium” category with the most recent “recommended” (weekly) release image.

Expected Result

The usual JupyterLab UI should be displayed.

Actual Result

Upon logging in the previous JupyterLab server session was available. It was not necessary to create a new one. (I.e., simply logging out, as instructed above, evidently does not stop the actual JL server process.)

Status: **Pass**

10 Description

Examine the JupyterLab file browser for the file created in **Step 5** above. If convenient (e.g., based on other distinctive files or persistent settings), verify further that the same user environment has been reached as with the non-NCSA credentials above.

Expected Result

The same file should be visible. (This verifies that the two sets of credentials lead to the same Notebook Aspect user environment.)

Actual Result

The ~/20191209.txt file was visible as expected, and other aspects of the session clearly showed that it was the same as the one reached via Caltech credentials.

Status: **Pass**

11 Description

Clone the test notebook for LDM-503-10a, “LDM-503-10a-test.ipynb”, into the user environment from the TBD tag of the TBD Github repository. Record the SHA that applies to the version of the test notebook that has been cloned.

Expected Result

Actual Result

The details of this bookkeeping were worked out after the substance of the test case and test plan were approved.

The appropriate instructions would have been:

1. Clone the "LVV-C85-unexecuted" tag of the lsst-dm/dmtr-161 repository into the Notebook Aspect user environment.
2. Copy the "notebooks/LDM-503-10a-test.ipynb" notebook to a new subdirectory of the repository clone, "executions/LVV-T1436".
3. Record the SHA-1 corresponding to the above tag.

The SHA-1 for "LVV-C85-unexecuted" is 6b560e5.

Status: **Pass**

12 Description

Copy the file "LVV-T1334-output.csv" that was saved in the output repository for the LVV-T1334 test case into the home directory of the notebook session.

Expected Result

Actual Result

Status: **Pass**

13 Description

Open the test notebook and insert the URL saved from the execution of LVV-T1334, Step 9 into the input cell that reads "portal_job_url = """.

Expected Result

Actual Result

The URL from Step 1 above was used instead: <https://lsst-lsp-stable.ncsa.illinois.edu/api/tap/async/gbupxri6cznn4jt7>, as the one from LVV-T1334 had expired due to the length of time elapsed since that test was performed.

Note that the copy of the test notebook in the "executions/LVV-T1436" directory was used for the test.

Status: **Pass**

14 Description

Execute the entire notebook.

Expected Result

Actual Result

Status: **Pass**

15

Description

Record the success and/or failure indications that appear in the final output cell of the notebook. If the notebook execution produced an exception, record that.

Expected Result

Actual Result

The final output of the notebook was:

Successfully completed query from notebook: True

Successful comparison to Portal query output: True

Successful comparison to TAP job from Portal query: True

Status: **Pass**

16

Description

Save and close the test notebook. Save the fully-executed notebook in TBD location as a record of the test.

Expected Result

Actual Result

The fully executed notebook was saved in the lsst-dm/dmtr-161 repository as "executions/LVV-T1436/LDM-503-10a-test.ipynb". Tag "LVV-T1436-e1" was applied.

Status: **Pass**

17

Description

Without logging out, open a new browser window or tab, and navigate to the Portal Aspect of the LSP instance under test. Verify that the Portal Aspect can be accessed without a further login. Verify that the username displayed at the upper right is the same one as in **Step 1** above.

Expected Result

Actual Result

The Portal Aspect TAP search screen opened immediately from the link from the lsst-lsp-stable landing page. User "Gregory Dubois-Felsmann" was displayed as expected.

Status: **Pass**

18

Description

Log out of the Notebook Aspect, close the Portal Aspect windows, and quit the Web browser in use.

Expected Result

Actual Result

Status: **Pass**

5.1.3.5 Test Case LVV-T1437 - LDM-503-10a: API Aspect tests for LSP with Authentication and TAP milestone

Open *LVV-T1437* test case in Jira.

This test case verifies that the TAP service in the API Aspect of the Science Platform is accessible to authorized users through a login process, and that TAP searches can be performed using the IVOA TAP protocol from remote sites.

In so doing and in conjunction with the other LDM-503-10a test cases collected under LVV-P48, it addresses all or part of the following requirements:

- DMS-LSP-REQ-0004, DMS-LSP-REQ-0005, DMS-LSP-REQ-0006, DMS-LSP-REQ-0020, DMS-LSP-REQ-0022, DMS-LSP-REQ-0023, DMS-LSP-REQ-0024
- DMS-API-REQ-0003, DMS-API-REQ-0004, DMS-API-REQ-0006, DMS-API-REQ-0007, DMS-API-REQ-0008, DMS-API-REQ-0009, DMS-API-REQ-0023, and DMS-API-REQ-0039, primarily

Note this test was not designed to perform a full verification of the above requirements, but rather to demonstrate having reached a certain level of partial capability during construction.

Preconditions:

Test case LVV-T1334 must have already been executed and the prescribed outputs saved, notably including the “LVV-T1334-output.csv” file.

Execution status: **Pass w/ Deviation**

Final comment:

Test executed against lsst-lsp-stable.

Minor concern: lack of usability of the latest version of the LSST “convenience API” for TAP service access from offsite; fixed by reverting to an earlier version.

Detailed steps results:

Step	Step Details
1	<p>Description</p> <p>On the local computer, clone the test notebook for LDM-503-10a, “LDM-503-10a-test.ipynb”, into the user environment from the TBD tag of the TBD Github repository. Note the SHA that applies to the version of the test notebook that has been cloned.</p> <hr/> <p>Expected Result</p> <hr/> <p>Actual Result</p> <p>The details of this bookkeeping were worked out after the substance of the test case and test plan were approved.</p> <p>The appropriate instructions would have been:</p> <ol style="list-style-type: none">1. Clone the “LVV-C85-unexecuted” tag of the lsst-dm/dmtr-161 repository into the Notebook Aspect user environment.2. Copy the “notebooks/LDM-503-10a-test.ipynb” notebook to a new subdirectory of the repository clone, “executions/LVV-T1437”.3. Record the SHA-1 corresponding to the above tag. <p>The SHA-1 for “LVV-C85-unexecuted” is 6b560e5.</p> <hr/> <p>Status: Pass</p>
2	<p>Description</p> <p>On the local computer, execute the command “pip install pyvo jupyterlabutils” in the local environment. (It is suggested to do this in a venv or conda environment.)</p> <hr/> <p>Expected Result</p> <hr/> <p>Actual Result</p> <p>It proved necessary to back up to jupyterlabutils 0.5.0 (the current version being 0.5.3) in order to avoid a token-validation failure below in Step 8. Note that the requirement for the offsite usability of the TAP-query-access convenience functions in this package has not been formally established.</p> <hr/>

Issues found executing this step:

DM-22538 jupyterlabutils 0.5.3 (current) does not work with the short tokens from the LSP get-token service

Status: **Pass w/ Deviation**

3 Description

Copy the file "LVV-T1334-output.csv" that was saved in the output repository for the LVV-T1334 test case into the home directory of the JupyterLab session.

Expected Result

Actual Result

Status: **Pass**

4 Description

Obtain an access token for the TAP service from the LSP instance under test, by navigating to the <https://lsst-lsp-stable.nsa.illinois.edu/auth/tokens> endpoint in a web browser and logging in. NCSA credentials for the tester should be used. Copy the access token to the clipboard.

Expected Result

Actual Result

The token `oauth2_proxy-3ce...5a7` was generated.

Status: **Pass**

5 Description

Within the Posix shell session from which JupyterLab is to be launched, set the environment variable "ACCESS_TOKEN" to the value of the token obtained in the previous step. To do this without exposing the token unnecessarily, it is suggested to use the "read -s" command, pasting the token in at the no-echo prompt this command produces.

Example Code

```
export ACCESS_TOKEN
read -s ACCESS_TOKEN
```

Expected Result

Actual Result

Status: **Pass**

6 Description

Launch a LOCAL instance of JupyterLab (i.e., by running “jupyter lab”) on the computer to be used for testing. Ensure that the test notebook is visible from within JupyterLab. **NB: as a reminder, this test case must NOT be run in the Notebook Aspect.**

Expected Result

Actual Result

Status: **Pass**

7 Description

Open the test notebook and insert the URL saved from the execution of LVV-T1334, Step 9 into the input cell that reads
“portal_job_url = ”.

Expected Result

Actual Result

<https://lsst-lsp-stable.ncsa.illinois.edu/api/tap/async/gbupxri6cznn4jt7> was inserted. (This was the URL generated at the start of LVV-T1436 to replace the one from LVV-T1334 which had expired.)

Status: **Pass**

8 Description

Execute the entire notebook.

Expected Result

Actual Result

The notebook runs to completion successfully.
(Note: It is at this stage that the “token-validation failure” mentioned in Step 2 above appears if a too-recent version of the “jupyterlabutils” package is installed.)

Status: **Pass**

9 Description

Record the success and/or failure indications that appear in the final output cell of the notebook. If the notebook execution produced an exception, record that.

Expected Result

Actual Result

The final output of the notebook was:

Successfully completed query from notebook: True

Successful comparison to Portal query output: True

Successful comparison to TAP job from Portal query: True

Status: **Pass**

10

Description

Save and close the test notebook. Save the fully-executed notebook in TBD location as a record of the test.

Expected Result

Actual Result

The fully executed notebook was saved in the lsst-dm/dmtr-161 repository as "executions/LVV-T1437/LDM-503-10a-test.ipynb". Tag "LVV-T1437-e1" was applied.

Status: **Pass**

A Traceability

Test Case	VE Key	VE Summary
LWV-T622	LWV-9830	DMS-LSP-REQ-0020-V-01: Authenticated User Access_1
LWV-T807	LWV-10014	DMS-API-REQ-0007-V-01: Synchronous TAP Support_1
LWV-T1334	LWV-9811	DMS-LSP-REQ-0002-V-01: Portal Aspect_1
	LWV-9809	DMS-LSP-REQ-0005-V-01: Linkage of Aspects_1
	LWV-9812	DMS-LSP-REQ-0006-V-01: Use of VO Standards_1
	LWV-9830	DMS-LSP-REQ-0020-V-01: Authenticated User Access_1
	LWV-9831	DMS-LSP-REQ-0022-V-01: Common Identity_1
	LWV-9834	DMS-LSP-REQ-0023-V-01: Use of External Identity Providers_1
	LWV-9835	DMS-LSP-REQ-0024-V-01: Use of Multiple Sets of Credentials_1
	LWV-9841	DMS-PRTL-REQ-0001-V-01: Portal is a Web Application_1
	LWV-9857	DMS-PRTL-REQ-0015-V-01: Generic Query_1
	LWV-9856	DMS-PRTL-REQ-0016-V-01: Generic Query - Form-based_1
	LWV-9855	DMS-PRTL-REQ-0017-V-01: Generic Query - ADQL-based_1
	LWV-9866	DMS-PRTL-REQ-0020-V-01: Positional Query: Position on the Sky_1
	LWV-9869	DMS-PRTL-REQ-0026-V-01: Positional Query by Region: Cone-Search_1
	LWV-9891	DMS-PRTL-REQ-0049-V-01: Display of Tabular Data_1
	LWV-9932	DMS-PRTL-REQ-0095-V-01: Saving Displayed Tabular Data_1
LWV-T1436	LWV-9810	DMS-LSP-REQ-0003-V-01: Notebook Aspect_1
	LWV-9809	DMS-LSP-REQ-0005-V-01: Linkage of Aspects_1
	LWV-9812	DMS-LSP-REQ-0006-V-01: Use of VO Standards_1

	LWV-9830	DMS-LSP-REQ-0020-V-01: Authenticated User Access_1
	LWV-9831	DMS-LSP-REQ-0022-V-01: Common Identity_1
	LWV-9834	DMS-LSP-REQ-0023-V-01: Use of External Identity Providers_1
	LWV-9835	DMS-LSP-REQ-0024-V-01: Use of Multiple Sets of Credentials_1
	LWV-9836	DMS-LSP-REQ-0026-V-01: Using secure protocols_1
	LWV-10000	DMS-NB-REQ-0001-V-01: Secure Protocol_1
	LWV-9998	DMS-NB-REQ-0002-V-01: Authentication and Authorization_1
	LWV-9971	DMS-NB-REQ-0005-V-01: Interactive Python Environment_1
	LWV-9976	DMS-NB-REQ-0006-V-01: Unix Shell Access_1
	LWV-9973	DMS-NB-REQ-0013-V-01: Persistent User Home File Space_1
	LWV-9980	DMS-NB-REQ-0017-V-01: Access to the API and Portal Aspects_1
	LWV-9996	DMS-NB-REQ-0029-V-01: Access to Portal-Initiated Queries_1
LWV-T1437	LWV-9808	DMS-LSP-REQ-0004-V-01: API (Data Access) Aspect_1
	LWV-9809	DMS-LSP-REQ-0005-V-01: Linkage of Aspects_1
	LWV-9812	DMS-LSP-REQ-0006-V-01: Use of VO Standards_1
	LWV-9830	DMS-LSP-REQ-0020-V-01: Authenticated User Access_1
	LWV-9831	DMS-LSP-REQ-0022-V-01: Common Identity_1
	LWV-9834	DMS-LSP-REQ-0023-V-01: Use of External Identity Providers_1
	LWV-9835	DMS-LSP-REQ-0024-V-01: Use of Multiple Sets of Credentials_1
	LWV-10034	DMS-API-REQ-0003-V-01: Authentication_1
	LWV-10035	DMS-API-REQ-0004-V-01: Authorization_1
	LWV-10015	DMS-API-REQ-0006-V-01: TAP Service for Tabular Queries_1

LWV-10014	DMS-API-REQ-0007-V-01: Synchronous TAP Support_1
LWV-10013	DMS-API-REQ-0008-V-01: Asynchronous TAP Support_1
LWV-10012	DMS-API-REQ-0009-V-01: ADQL Support_1
LWV-10002	DMS-API-REQ-0023-V-01: Access to Catalog Data Products_1
LWV-10019	DMS-API-REQ-0039-V-01: Cached Query Result Retrieval_1
LWV-10037	DMS-API-REQ-0001-V-01: Secure Protocols_1

B Acronyms used in this document

Acronym	Description
2D	Two-dimensional
2MASS	Two-Micron All Sky Survey
ADQL	Astronomical Data Query Language
API	Application Programming Interface
CSV	Comma Separated Values
DM	Data Management
DMS	Data Management Subsystem
DMTR	DM Test Report
HTML	HyperText Markup Language
HTTP	HyperText Transfer Protocol
IPAC	No longer an acronym; science and data center at Caltech
IVOA	International Virtual-Observatory Alliance
LDF	LSST Data Facility
LDM	LSST Data Management (Document Handle)
LSE	LSST Systems Engineering (Document Handle)
LSP	LSST Science Platform
LSST	Large Synoptic Survey Telescope
NCSA	National Center for Supercomputing Applications
OS	Operating System
PDAC	Prototype Data Access Center
SDSS	Sloan Digital Sky Survey
SHA-1	Secure Hash Algorithm 1
TAP	Table Access Protocol
TBD	To Be Defined (Determined)
UI	User Interface
UX	User Experience
VO	Virtual Observatory
WISE	Wide-field Survey Explorer
XML	eXtensible Markup Language