Liferay Digital Experience Platform Performance

Benchmark Study of Liferay DXP 7.1

Liferay

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Executive Summary

Liferay Digital Experience Platform (DXP) is software to create, manage and optimize digital experiences across multiple customer touchpoints. The platform contains both on-premise and cloud-based components, and this deployment checklist focuses on the on-premise deployed components, specifically the core portal component Liferay DXP 7.1. Liferay DXP's cloud-based components are automatically tuned and optimized by Liferay's engineering teams.

The Liferay engineering team performed intensive tuning and testing to demonstrate the scalability of Liferay DXP 7.1 in a collection of use cases including infrastructure portal, collaboration and content management.

The goals of this study were to:

- Determine the maximum number of virtual users supportable by a single physical server across defined test cases.
- Determine if Liferay DXP provides linear scalability (i.e., if we double the number of portal application servers, we should be able to double the number of supported virtual users).
- Provide statistics to help Liferay Global Services, Liferay Enterprise Subscription clients, and Liferay Service Partners in capacity planning.

To help accurately demonstrate "enterprise scale," this study was commissioned with:

- 1 million total users
- 2 million documents with an average of 100KB per document
- 10,000 sites with 50% of the sites having at least 5 children
- 4 million message forum threads and posts
- 100,000 blog entries and 1 million comments
- 100,000 wiki pages

Key Findings

The key findings of the study are:

1. As an infrastructure portal, Liferay DXP can support over 47,000 virtual users on a single server with mean login times under 312 ms and maximum throughput of 1320+ logins per second.
2. The platform's Document Repository easily supports over 26,000 virtual users while accessing 2 million documents in the document repository.
3. The platform's WCM scales to beyond 300,000 virtual users on a single Liferay DXP server with average transaction times under 50ms and 35% CPU utilization.
4. In collaboration and social networking scenarios, each physical server supports over 15,000 virtual concurrent users at average transaction times of under 800ms.
5. Given sufficient database resources and efficient load balancing, Liferay DXP can scale linearly as one adds additional servers to a cluster. With a properly configured system, by doubling the number of Liferay DXP servers, you will double the maximum number of supported virtual user.

Test Scenarios

The document utilizes the following conventions when discussing test cases and results:

- Virtual Users – Simulated users concurrently transacting on the portal system. Transactions vary depending upon the test cases.
- Total Users – Total number of users in the portal database that could be used as part of a test.

Each portal deployment is unique in its requirements and performance characteristics. Liferay collaborated with clients across a broad spectrum of industries to determine the scenarios that best modeled product use cases. Based on this feedback, Liferay decided to classify the test cases into three categories:

- Transaction centric scenarios
  - Apply to financial, insurance and ecommerce deployments where a large number of users will login and perform transactions like online banking (e.g., bill payments), online insurance applications, airline and hotel booking.
  - Frequent authenticated access with longer average user session times.
- Collaboration centric scenarios
  - Apply to corporate intranets looking to leverage shared document repositories with other social collaboration tools like blogs, wikis and forums.
  - Apply to Facebook-like social networks and developer communities.
  - Mostly authenticated access; roughly 5:1 ratio between read and write transactions.
- Content and document management scenarios
  - Apply to corporate intranets and customers looking to manage and share documents.

Benchmark Configuration and Methodology

Environment Configuration

The benchmark environment conforms to deployment architecture best practices. It consists of the following tiers:

1. Web Server Tier – deliver static content elements like images, rich media, and other static files like style sheets.
2. Application Tier – hosts Liferay supported application servers like Tomcat, JBoss, Oracle WebLogic, and IBM WebSphere (please see Liferay DXP Compatibility Matrix for additional platforms).
3. Database Tier – hosts Liferay supported database servers like MySQL, Oracle, MS SQL, IBM DB2, Postgres (please see Liferay DXP Compatibility Matrix for additional platforms).

For simplicity, Liferay opted to not insert a firewall or a hardware load balancer into the benchmark environment.

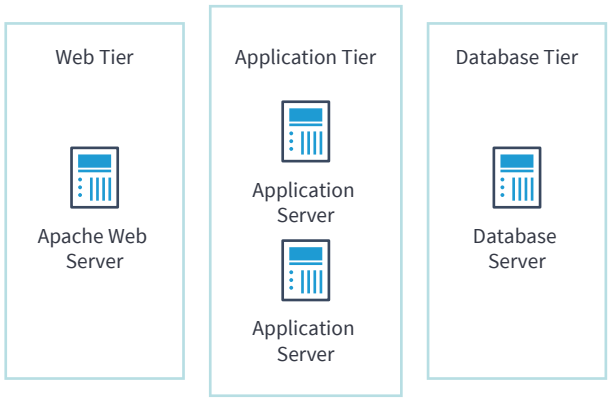

Figure 1 - Benchmark Configuration

Hardware platforms:

1. Web Server
    - 1 x Intel Core i7-3770 3.40GHz CPU, 8MB L2 cache
    - 16GB memory
2. Application Server
    - 2 Intel Xeon E5-2643 v4 3.40GHz CPU, 20MB L2 cache
    - 64GB memory, 2 x 300GB 15k RPM SCSI
3. Database Tier
    - 2 Intel Xeon E5-2643 v4 3.40GHz CPU, 20MB L2 cache
    - 64GB memory, 2 x 300GB 15k RPM SCSI

Network:

- 3 Gigabit network between all servers and test clients

Software:

- Liferay DXP 7.1
- Sun Java 8 (1.8.0_65)
- Tomcat 9.0.6
- CentOS 7.3 64-bit Linux (minimal installation)
- MySQL 5.7.9 Community Server
- Apache HTTPD Server 2.2
- Grinder 3 load test client with Liferay customizations

Methodology

Liferay utilized the Grinder load testing tool and its distributed load injectors. In all test scenarios, the injectors ramped up users at a rate of one user every 100 milliseconds until achieving the desired virtual user load.

The benchmark data was gathered after an initial ramp up time of 10 minutes to initialize all application elements and warm up all injectors. As part of data gathering, the following statistics were gathered:

- OS level statistics on web, application and database servers (includes CPU, context switches, IO performance).
- JVM garbage collection information via Visual VM and garbage collector logs.
- Average transaction times, standard deviations and throughput from the Grinder console.

A single application server was used to determine maximum throughput. Once the maximum throughput was reached on a single server, Liferay added a second application server to prove the linear scalability hypothesis: that doubling the available application server hardware will double the maximum number of virtual user supported by the system.

Benchmark Results

Transaction Centric Scenarios

Isolated Login

The first of two transaction centric scenarios focuses on the login process of Liferay DXP. The login and permission retrieval process is one of the most resource intensive processes within the portal. At login, the portal must retrieve user and security information from the database and calculate authorizations.

We first examine Liferay DXP's performance with simple content portlets on the page. These portlets are extremely fast, lending average rendering times of less than 10ms.

Table 1 illustrates the performance observed during this test. The mean time for login remains less than 300ms as we approach the performance inflection point. At 47,000 virtual users, we have a mean time (μ) of 312 ms and 95% of the logins (2σ) around 814 ms. The optimal performance point with relatively small standard deviation occurs somewhere around 46,750 virtual users.

At 48,000 virtual users, we exceed the established performance budget of this test (i.e., sub 1 second login times). Thus, the performance inflection point for login is roughly between 47,000 and 48,000 virtual users while stable performance and throughput is around 47,000 virtual users.

Virtual Users	Duration (min)	μ (ms)	σ (ms)	2σ (ms)	Login Throughput (TPS)	CPU Utilization (%)
43000	30	23.3	29.5	82.3	1230	85
44000	30	35.1	50.1	135.5	1260	89
45000	30	60.3	90.5	241.3	1280	93
46000	30	104	146	396	1310	94
46500	30	143	170	483	1320	95
46750	30	249	198	645	1320	95
47000	30	312	251	814	1320	96
48000	30	801	199	1199	1320	95
49000	30	1010	278	1556	1340	95

Table 1 – Isolated Login

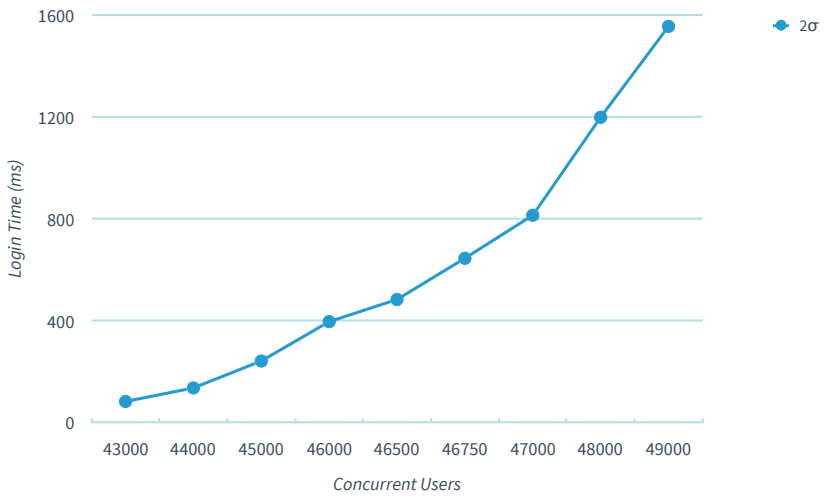

Figure 2: Mean Login Time

During peak load, the portal has an optimal throughput for the login transaction of 1000 transactions per second.

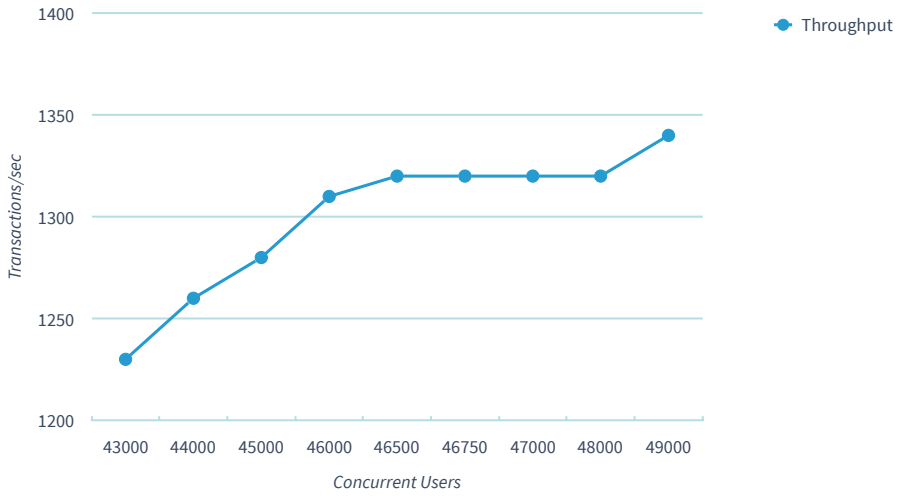

Figure 3: Isolated Login Throughput

Upon maxing out a single application server, a second portal application server was deployed. The benchmark results showed that Liferay DXP was able to breach 94,000 virtual users using two application servers. At 94,000 users across two application servers, the performance characteristics remained identical to those gathered with 47,000 users on a single application server. The second Liferay DXP JVM instance was deployed to an identically sized server.

Login with Legacy Simulator

This test scenario helps demonstrate the impact of adding a portlet that will sleep for 2 seconds. The 2 seconds simulate the impact of integration with systems like Salesforce.com or interacting with a company's enterprise service bus. The hypothesis is that individual portlet performance will have impacts on the overall performance of the portal solution.

The statistics indicate a decrease in the maximum number of concurrent users prior to reaching the optimum performance point. In this scenario, the portal reaches optimal throughput and performance at roughly 18,500 virtual users, 28,250 users less than the previous login scenario. At the inflection point, we see that 95% (2σ) of the combined login and homepage transactions consume 2.67s with a mean time of 2.19s.

Unlike in the isolated login test case, this test case was only able to utilize 40% of the CPU at peak throughput. This is due to the slower transaction response times (e.g. 2s). This can potentially be resolved by adding a second JVM to service requests.

Virtual Users	Duration	Time Delayed Page μ (ms)	Time Delayed Page σ (ms)	Time Delayed Page 2σ (ms)	Throughput (TPS)	CPU (%)
13000	30	2020	39.1	2098.2	333	25
15000	30	2030	63.3	2156.6	383	31
16000	30	2040	83.8	2207.6	409	32
17000	30	2060	116	2292	434	33
17500	30	2080	143	2366	445	36
18000	30	2100	153	2406	458	36
18500	30	2190	242	2674	469	39
19000	30	2420	366	3152	476	42
20000	30	3400	512	4421	479	43
20500	30	3840	504	4848	481	43
21000	30	4430	518	5466	481	43

Table 2 – Login with Simulator

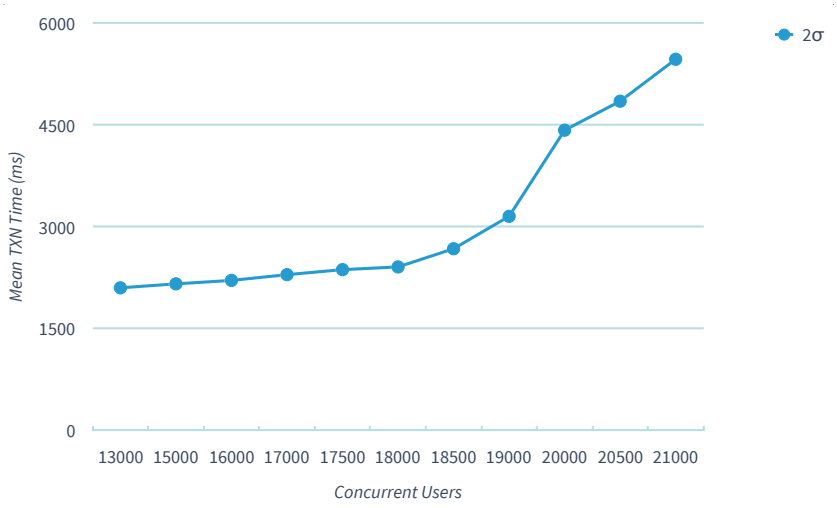

Figure 4: Legacy Login

Figure 4 illustrates Liferay DXP approaching its optimal performance just above the 18,500 virtual users threshold.

As with the first scenario, a second portal application server was deployed upon determining the inflection point. The benchmark results showed that Liferay DXP was able to breach 37,000 virtual users using two application servers. At 37,000 users, the transaction times remained similar to the times gathered on a single application server.

This test confirms that individual portlets will have an impact on the performance of the overall portal solution. Slower portlet transactions will decrease the maximum concurrent user load each physical server may support.

Collaboration Scenarios

Message Boards

Message Boards represents one of the foundational elements around social collaboration. The message board test cases demonstrate the full range of capabilities for the Liferay Message Board, simulating how an end user may utilize the features. In Table 4 and 5, we see the breakdown for each individual transaction within the test, including login, browsing and posting.

In almost every case, 95% of the transactions remain under 2s when we have roughly 16,000 virtual users. At 17,000 users, we see that the system has begun to exceed the performance inflection point.

Virtual Users	Duration (min)	Login Time μ(ms)	Login Time σ(ms)	Browse Category μ(ms)	Browse Category σ(ms)	Browse Thread μ(ms)	Browse Thread σ(ms)	Browse Posts μ(ms)	Browse Posts σ(ms)
12000	30	17.9	21.8	43.8	18.9	41	32.1	84.9	32.2
13000	30	17.6	21	43.9	17.4	41.4	31.9	88.8	37.8
14000	30	19.2	31.3	46.7	23.8	43.9	35.6	99.6	59.9
14500	30	22.2	47.5	49	30.7	46.1	40.9	112	84.5
15000	30	20.6	38.5	48.9	28.3	45.4	38.9	119	76.1
15500	30	21.3	35.7	50.8	26.3	46.9	39.1	133	81.8
16000	30	32.5	85	57.3	43.8	53.2	53.2	162	132
17000	30	939	2390	531	1260	399	940	686	1320
18000	30	2310	3500	1420	2030	1000	1520	1610	2010

Table 4 – Message Boards Part 1

Virtual Users	Post Thread μ(ms)	Post Thread σ(ms)	Reply Thread μ(ms)	Reply Thread σ(ms)	Total μ(ms)	Total σ(ms)	Total 2σ(ms)	CPU (%)
12000	48.7	21.5	45.6	24.5	281.9	151	583.9	43
13000	49.1	24	45.8	22.8	286.6	154.6	596.4	46
14000	52.7	30.2	48.6	29.2	310.7	210	730.7	50
14500	56.3	44.4	53.4	46.7	338.9	294.7	928.3	52
15000	56.9	41	52.2	38.9	343	261.7	866.4	53
15500	58	37.1	54.2	36.1	364.2	256.1	876.4	55
16000	70.7	74.1	64.5	68.3	440.2	456.4	1352	59
17000	696	1730	802	1920	4053	9560	23173	55
18000	1660	2600	2210	3130	10210	14790	39790	51

Table 5 – Message Boards Part 2

Figure 5 shows us that the optimal performance point at 16,000 virtual users for a single JVM.

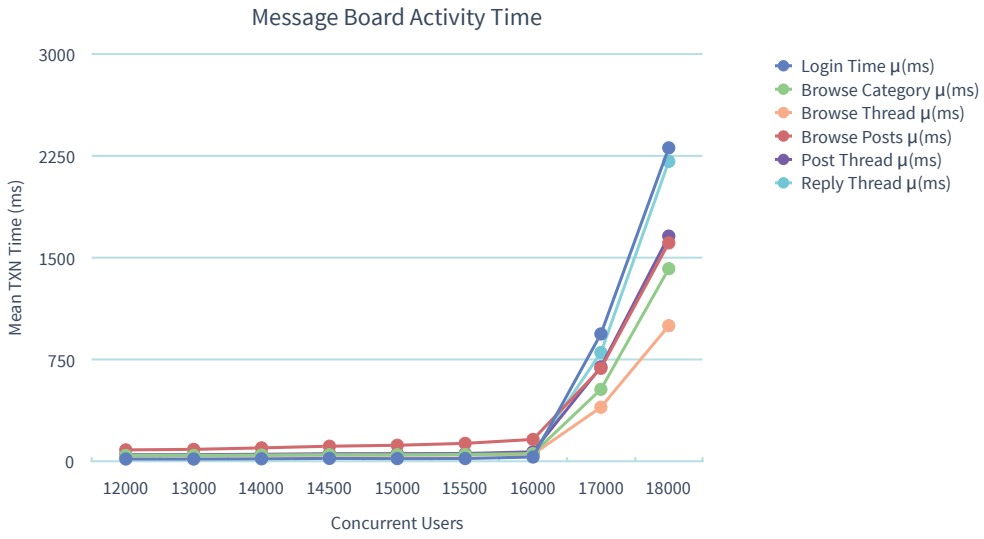

Figure 5: Collaboration Performance

As with previous tests, Liferay confirmed that the maximum user threshold doubled when doubling the number of physical servers.

Blogging

Blogging is another cornerstone for social collaboration. As with the message board test cases, we attempt to simulate real end user behavior of browsing, reading and contributing to blogs. While the blogging components in Liferay reuse some of the components of the Message Boards, we do see somewhat different performance due to the reduced complexity of the Blogs features (e.g., no nested categories and thus reduced entitlement validation).

As shown in Tables 6 and 7, the statistics point to a performance inflection point of roughly 17,000 virtual users. At this load, we observed total mean transaction times (μ) at 726ms with 95% of all transactions consuming roughly 2.2s. Individual transactions are substantially lower. For instance, to post comments on a blog and to post a new blog entry, the statistics report 95% of the transaction at about 176 ms and 229 ms respectively.

Virtual Users	Duration (min)	Login Time μ(ms)	Login Time σ(ms)	View Summaries σ(ms)	View Summaries σ(ms)	View Entry μ(ms)	View Entry σ(ms)
13000	30	18.6	29.7	36	20.7	35	21.3
14000	30	22.4	38.1	42.3	26.1	42	28.1
15000	30	25.6	46.2	46.4	30.4	46.3	33.3
15500	30	29.5	57.6	49.8	35.6	50.3	38.8
16500	30	49.7	93.3	66.8	52.5	67.3	56.5
17000	30	122	211	103	90.9	106	97.1
17500	30	586	762	327	376	316	396
18000	30	969	931	531	482	476	520
18500	30	1590	995	793	508	692	600
19500	30	2250	2270	1500	948	1160	1020
20000	30	2740	2870	1820	1080	1400	1190

Table 6– Blogs Part 1

Virtual Users	Post New Entry μ(ms)	Post New Entry σ(ms)	Post Comment μ(ms)	Post Comment σ(ms)	Total μ(ms)	Total σ(ms)	Total 2σ(ms)	CPU (%)
13000	68	34.2	74.7	36.3	232.3	142.2	516.7	59
14000	76.9	38.7	93.5	47.2	277.1	178.2	633.5	69
15000	83.9	47.5	105	55.5	307.2	212.9	733	77
15500	89.3	56.8	113	67.4	331.9	256.2	844.3	78
16500	116	87.1	152	102	451.8	391.4	1234.6	84
17000	176	163	229	188	726	750	2226	91
17500	466	576	514	567	2159	2677	7513	86
18000	606	626	830	784	3412	3343	10098	88
18500	939	741	1340	930	5354	3774	12902	90
19500	2230	1870	2670	1870	9810	7978	25766	91
20000	3000	2250	3390	2100	12350	9490	31330	93

Table 7– Blogs Part 2

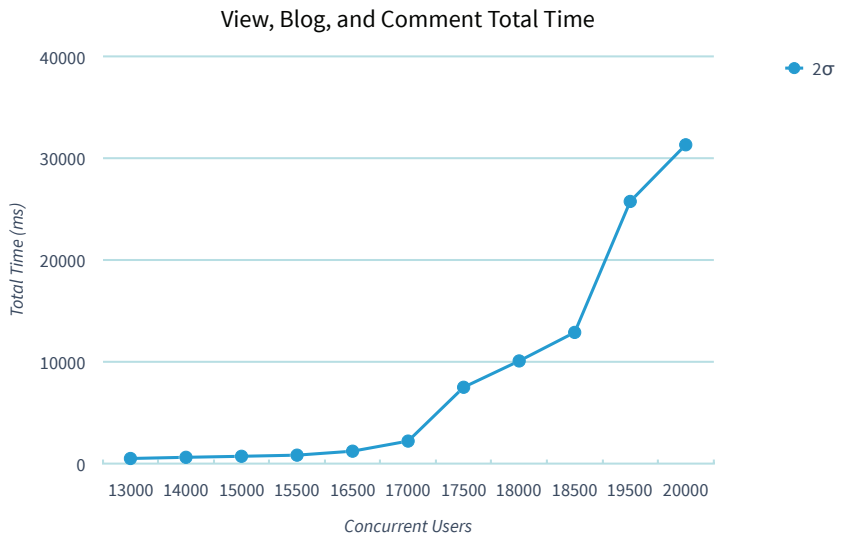

Figure 6: 95% Transaction Time for Blogging Test Case

Figure 6 depicts the total mean transaction time as the system approaches the optimal performance point. From the Table 7, we see total mean transaction time moving to 1.2s at 16,500 users, from 844.3 ms at 15,500 virtual users. Based on the statistics, the most stable performance point is somewhere between 15,000 and 15,500 users.

Content and Document Management

Liferay provides rich capabilities for both Web Content Management and Document Management. The Documents and Media features are backed by a full featured content repository that supports multilevel workflow approvals, custom document metadata definitions and social collaboration features (e.g., ratings, comments).

The performance test cases demonstrate the typical usage scenarios with users browsing for files, viewing file details (e.g., metadata, comments, ratings), download the file and finally uploading new files. The testing environment removes potential network bottlenecks by providing fast network connections between clients downloading files and the document repository (3Gbps).

As shown in Table 8, overall transaction times for browsing, viewing, uploading and downloading documents remain sub second across most transactions. At the performance inflection point of 26000 users, 95% of file downloads occurred in 100ms for a 100KB document. Document upload times for a 100KB document with 26,500 virtual users remains under 1s, coming in at 673ms for 95% of the users.

Virtual Users	Duration (min)	Browse Folder μ(ms)	Browse Folder σ(ms)	View File Details μ(ms)	View File Details σ(ms)	Download File μ(ms)	Download File σ(ms)	Upload File μ(ms)	Upload File σ(ms)
24000	30	58.5	145	55.2	64.5	19	52.2	153	127
24500	30	82.1	66	61.1	59.7	21.1	47.2	170	119
25000	30	98.8	104	78.5	97.5	36.6	84.5	202	191
25500	30	112	88.5	87	82.5	41.2	71	227	168
26000	30	156	129	119	117	73.8	113	297	236
26500	30	329	283	259	262	227	270	673	572
27000	30	782	591	782	591	502	537	1840	1180
28000	30	859	559	873	561	670	530	1830	1100
29000	30	1010	499	938	509	902	477	1870	896

Table 8– Document Library

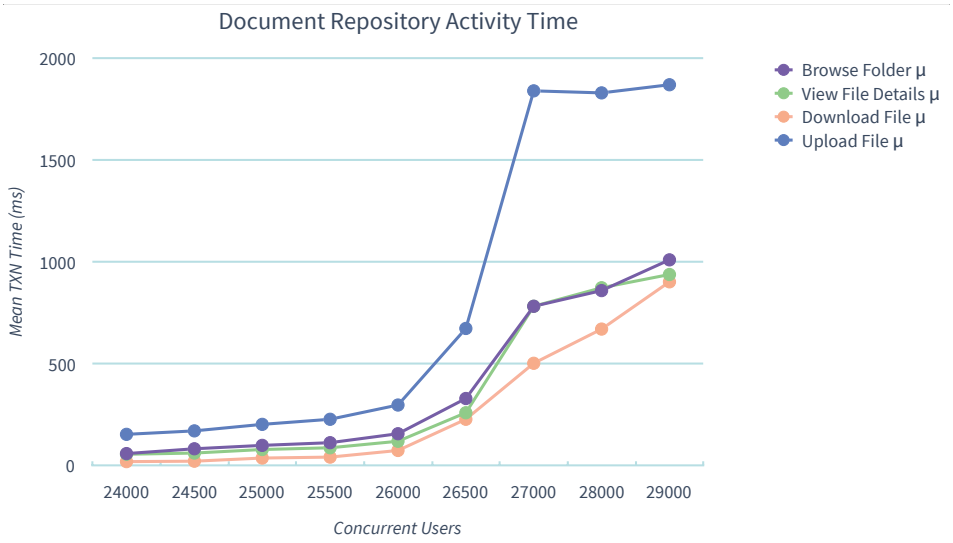

Figure 7– Document Repository Mean Time

Summary

Liferay Engineering, in collaboration with various clients and partners, commissioned this benchmark study to demonstrate the performance and scalability of Liferay DXP and to provide statistics for future capacity planning.

Based on the results of this study, Liferay determined that Liferay Digital Experience Platform provides an extremely scalable and high performance environment for building an infrastructure portal, a collaboration portal, a content portal, and any combination of these capabilities. With its immense flexibility and proven performance and scalability, Liferay believes Liferay DXP is uniquely positioned to help bring Web 2.0 capabilities to the enterprise.

Due to the many performance enhancements introduced in Liferay DXP, the benchmarks apply to Liferay DXP 7.1 and not Liferay Portal 7.1 Community Edition. This approach ensures that Liferay Enterprise Subscription customers realize the benefits of the engineering team's testing immediately while also providing similar benefits to Liferay's open source community in a future Community Edition release.

Acknowledgements

Liferay would like to thank those in the Liferay customer network for their contributions in helping develop performance test cases. Liferay would also like to thank members of the Liferay open source community for their important contributions in performing independent benchmarking and testing.

Moving Forward

Contact Us

For more information about Liferay DXP, contact us at sales@liferay.com.

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