

Liferay Digital Experience Platform Performance

Benchmark Study of Liferay DXP 7.3

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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 study focuses on the on-premise deployed components, specifically the core portal component Liferay DXP 7.3. 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 7.3 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 35,000 virtual users on a single server with mean login times under 445 ms and maximum throughput of 978 logins per second.
2. The platform's Document Repository easily supports over 23,500 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 users.

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.

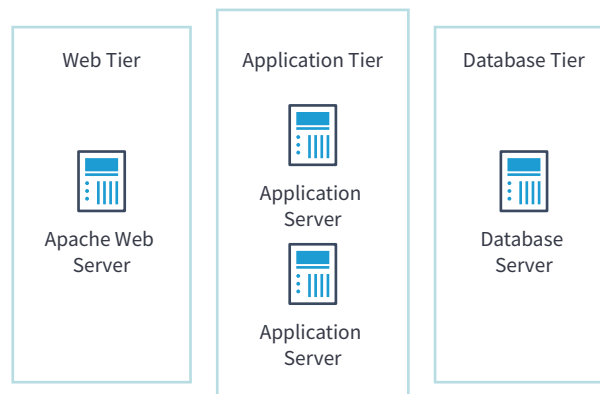


Figure 1 - Benchmark Configuration

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 7.3
- 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 users 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 35,000 virtual users, we have a mean time (μ) of 445 ms and 95% of the logins (2σ) around 797 ms. The optimal performance point with relatively small standard deviation occurs somewhere around 35,500 virtual users.

At 35,500 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 35,000 and 35,500 virtual users while stable performance and throughput is around 35,000 virtual users.

Virtual Users	Duration (min)	μ (ms)	σ (ms)	2σ (ms)	Login Throughput (TPS)	CPU Utilization (%)
30000	30	25.5	21.5	68.5	856	79
32000	30	36.5	35.9	108.3	913	87
33000	30	53.3	60.1	173.5	939	89
34000	30	82.7	114	310.7	967	94
34500	30	205	157	519	975	95
35000	30	445	176	797	978	95
35500	30	798	198	1194	976	96
37000	30	1740	160	2060	976	95
38000	30	2270	161	2592	980	95

Table 1 - Isolated Login

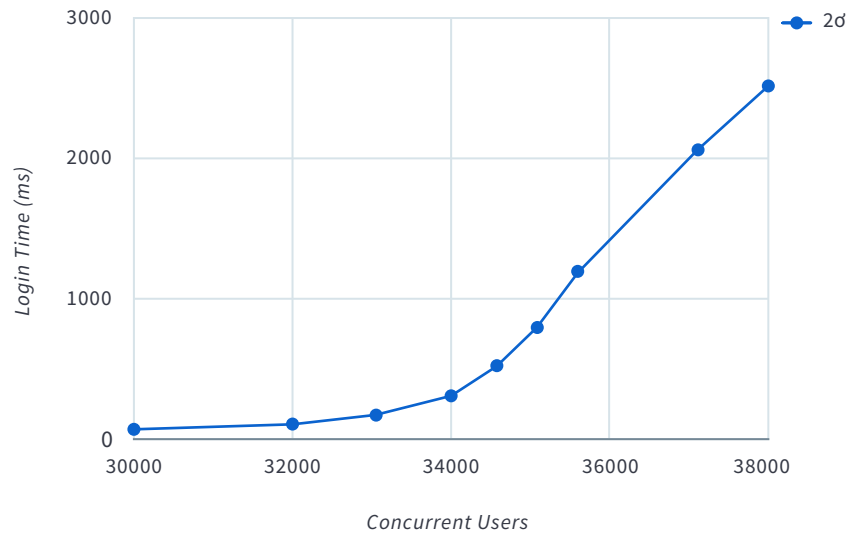


Figure 2: Mean Login Time

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

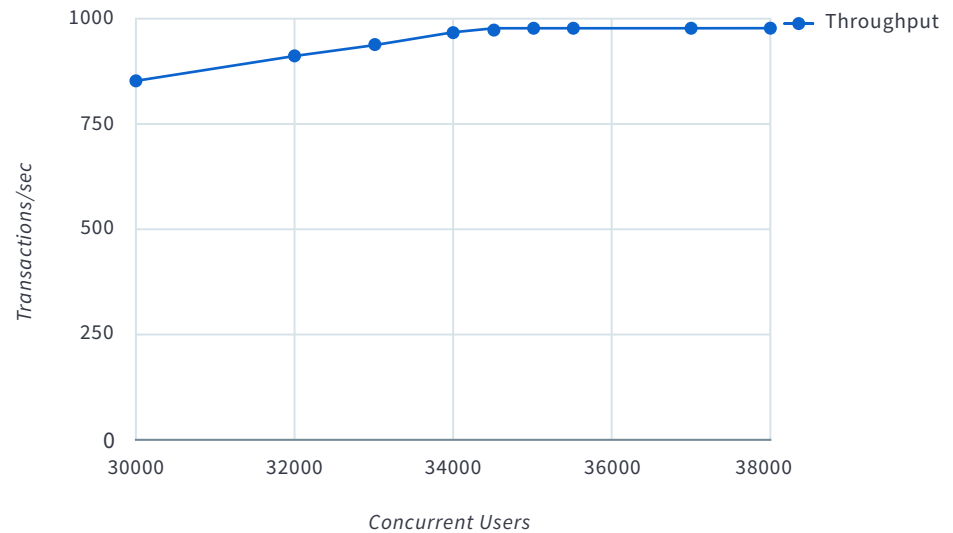


Figure 3: Isolated Login Throughput

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 24,500 virtual users, 10,500 users less than the previous login scenario. At the inflection point, we see that 95% (2σ) of the combined login and homepage transactions consume 2.91s with a mean time of 2.25s.

Unlike in the isolated login test case, this test case was only able to utilize 80% 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 (%)
19000	30	2060	99.9	2259.8	511	63
20000	30	2060	121	2302	538	66
21000	30	2130	322	2774	561	68
22000	30	2110	166	2442	590	72
23000	30	2130	189	2508	616	75
23500	30	2170	217	2604	627	75
24000	30	2140	166	2472	642	78
24500	30	2250	333	2916	652	79
25000	30	2450	694	3838	658	80
26000	30	2800	1030	4860	674	82
27000	30	3730	1580	6890	670	75

Table 2 - Login with Simulator

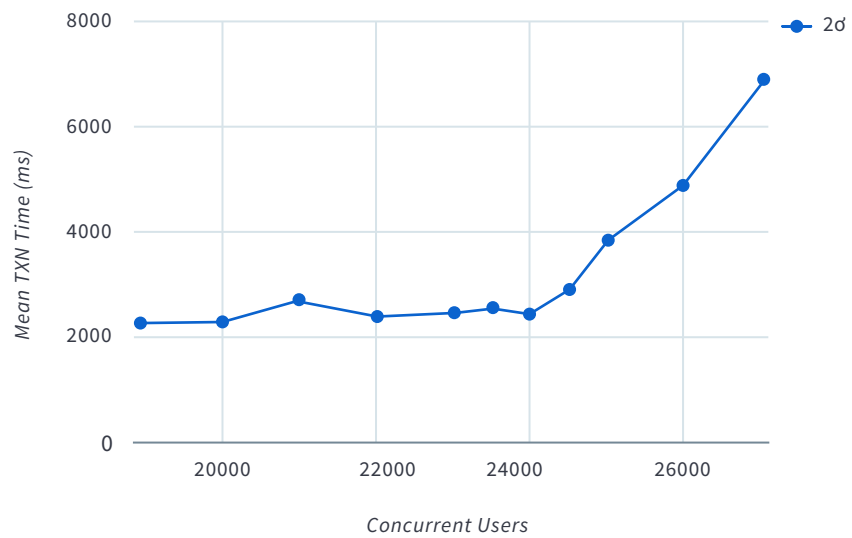


Figure 4: Legacy Login

Figure 4 illustrates Liferay DXP approaching its optimal performance just above the 24,500 virtual users threshold.

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 14,000 virtual users. At 15,000 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)
10000	30	21.6	18.6	49	17.6	28.5	23.9	76.9	24.7
11000	30	22.4	13	51.6	16.6	29.9	22.9	84.1	24.9
12000	30	23.4	18.1	52.9	21.6	30.3	25.3	88.1	34.5
13000	30	23.8	17.1	54	20.8	32	26	93.9	36
13500	30	26.2	27.1	59	30.6	33.9	30.2	106	56.1
14000	30	39.6	84.4	68.7	52.6	41.6	50.6	150	128
15000	30	368	1290	164	213	551	498	334	656
16000	30	691	2120	412	991	299	847	566	1090
17000	30	1900	2910	1070	1650	812	1330	1250	1670

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 (%)
10000	46.4	21.9	40.9	23	263.3	129.7	522.7	42
11000	48.7	17	42.6	15.4	279.3	109.8	498.9	45
12000	50.1	22.8	44.2	19.4	289	141.7	572.4	48
13000	51.4	18.9	45.7	18.9	300.8	137.7	576.2	52
13500	55.3	30.7	48.8	30.2	329.2	204.9	739	55
14000	71.2	75.7	62.2	70.7	433.3	462	1357.3	51
15000	355	1070	323	1000	2095	4727	11549	52
16000	584	1570	659	1740	3211	8358	19927	55
17000	1500	2190	1460	2270	7992	12020	32032	50

Table 5 – Message Boards Part 2

Figure 5 shows us that the optimal performance point at 14,000 virtual users for a single JVM.

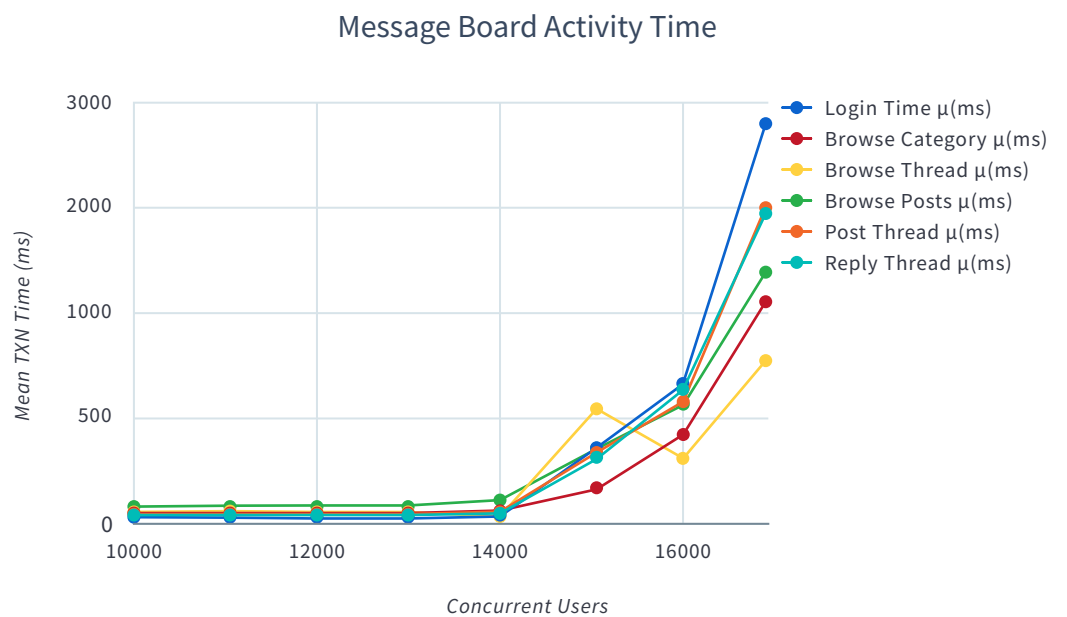


Figure 5: Collaboration Performance

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 14,000 virtual users. At this load, we observed total mean transaction times (μ) at 499ms with 95% of all transactions consuming roughly 1.16s.

Individual transactions are substantially lower. For instance, to post comments on a blog and a new blog entry, the statistics report 95% of the transaction at about 158 ms and 131 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)
10000	30	27.9	20.3	43.5	18.8	39.6	18.4
11000	30	25.1	14.3	40.6	14.3	36.9	14.5
12000	30	26.5	18	42.4	16.6	38.3	16.7
13000	30	34.5	39.9	51.6	29.3	47.1	29.2
13500	30	37.2	33.8	56.9	28.9	51.9	30.1
14000	30	58.2	76.2	77.8	45.7	74	50.4
14500	30	124	188	115	81.4	112	87.3
15000	30	247	304	164	122	162	127
15500	30	1590	833	728	407	630	488
16000	30	2030	973	857	441	721	485
17000	30	2860	1000	1380	509	1080	561

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 (%)
10000	79.9	26	79.6	28.6	270.5	112.1	494.7	75
11000	75	18.3	75.6	20.9	253.2	82.3	417.8	67
12000	78.2	23.7	79.6	25.5	265	100.5	466	74
13000	92.1	42.6	97.8	51.8	323.1	192.8	708.7	83
13500	100	43.1	107	48.7	353	184.6	722.2	87
14000	131	73	158	87.8	499	333.1	1165.2	91
14500	195	149	231	166	777	671.7	2120.4	93
15000	290	227	328	240	1191	1020	3231	93
15500	835	616	1230	951	5013	3295	11603	93
16000	1360	823	1710	776	6678	3498	13674	94
17000	2220	841	2270	888	9810	3799	17408	94

Table 7 - Blogs Part 2

View, Blog and Comment Total Time

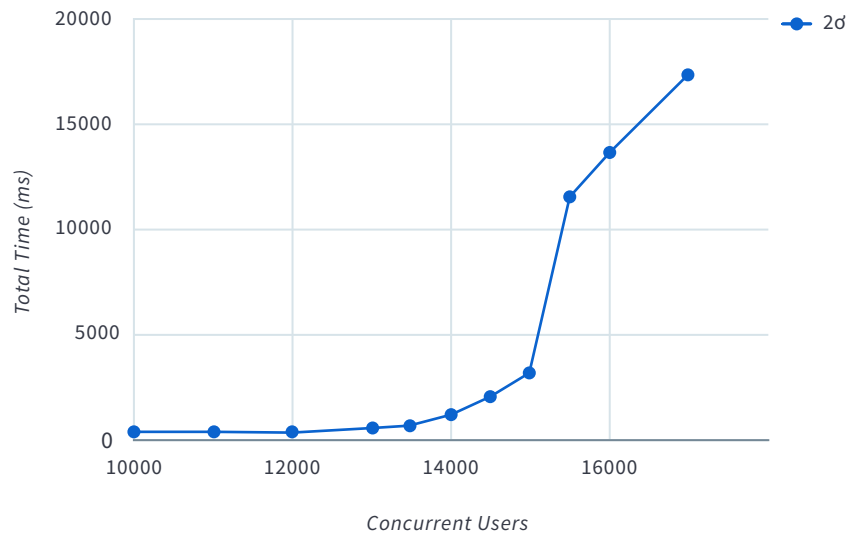


Figure 6: 95% Transaction Time for Blogging Test Case

Figure 6 depicts the total mean transaction time as the system approaches the optimal performance point. From Table 7, we see total mean transaction time moving to 1.16s at 14,000 users, from 722 ms at 13,500 virtual users. Based on the statistics, the most stable performance point is somewhere between 13,500 and 14,000 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), downloading 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 23500 users, 95% of file downloads occurred in 100ms for a 100KB document. Document upload times for a 100KB document with 23,500 virtual users remains under 1s, coming in at 272ms 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)
20000	30	57.2	27.8	36.7	22.4	6.25	10.4	108	42.6
21000	30	63.7	31.8	41.4	24.4	7.33	10.3	122	48.3
22000	30	77.6	46.5	51	37.9	10.7	25.4	144	75.7
23000	30	109	69.3	71.4	56.7	22.2	45.5	191	113
23500	30	154	105	110	95.9	54.5	86.7	272	191
24000	30	544	452	319	382	326	391	1070	904
25000	30	827	565	605	517	632	534	1560	1130
26000	30	1290	352	1240	359	1190	345	2520	608
27000	30	1670	126	1620	127	1560	124	3290	255

Table 8 - Document Library

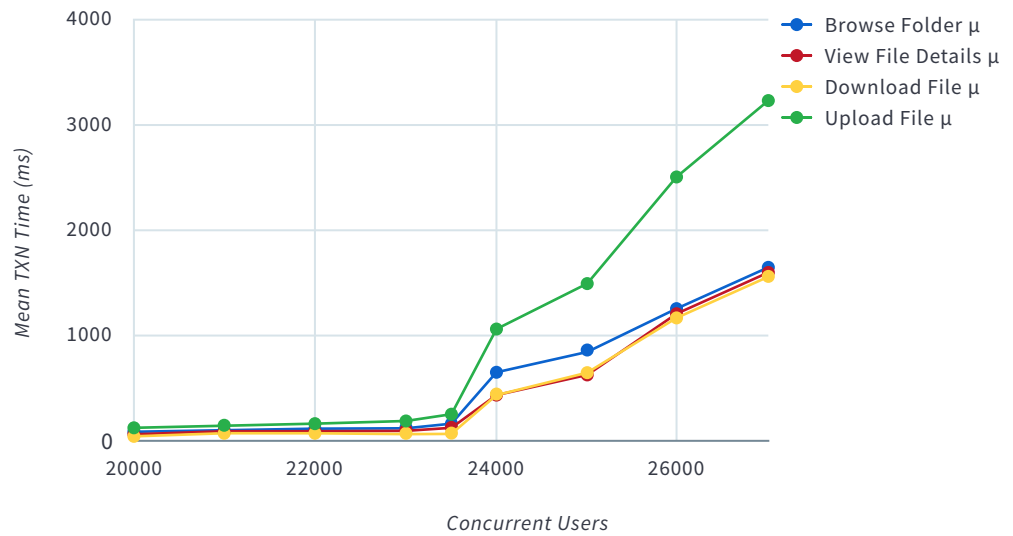


Figure 7 - Document Repository Mean Time

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 out connected solutions for any combination of transaction, collaboration, and content-centric scenarios now and in the future. With its immense flexibility and proven performance and scalability, Liferay believes that Liferay DXP is uniquely positioned to help enterprises successfully achieve digital transformation.

Due to the many performance enhancements introduced in Liferay DXP, the benchmarks apply to Liferay DXP 7.3 and not Liferay Portal 7.3 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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