Liferay Digital Experience Platform Performance

Benchmark Study of Liferay Digital Enterprise 7.0

LIFERAY

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Executive Summary

Liferay provides software to create, manage and optimize digital experiences across multiple customer touchpoints. Liferay is recognized by Gartner as a Leader in the Magic Quadrant for Horizontal Portals through Liferay Digital Experience Platform (DXP), its flagship product. Liferay DXP 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 Digital Enterprise 7.0. 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 Digital Enterprise 7.0 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 Digital Enterprise 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 Digital Enterprise can support over 36,250 virtual users on a single server with mean login times under 378 ms and maximum throughput of 1020+ logins per second.
2. The platform's Document Repository easily supports over 18,000 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 Digital Enterprise server with average transaction times under 50ms and 35% CPU utilization.
4. In collaboration and social networking scenarios, each physical server supports over 8,000 virtual concurrent users at average transaction times of under 800ms.
5. Given sufficient database resources and efficient load balancing, Liferay Digital Enterprise can scale linearly as one adds additional servers to a cluster. With a properly configured system, by doubling the number of Liferay Digital Enterprise 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 Digital Enterprise Compatibility Matrix* for additional platforms).
3. Database Tier – hosts Liferay supported database servers like MySQL, Oracle, MS SQL, IBM DB2, Postgres (please see *Liferay Digital Enterprise Compatibility Matrix* for additional platforms).

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

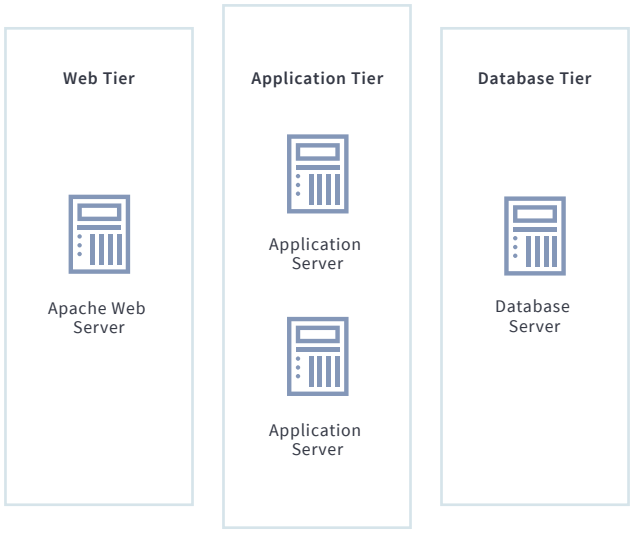

Figure 1 - Benchmark Configuration

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, 4 x 146GB 15k RPM SCSI

Network:

- 3 Gigabit network between all servers and test clients

Software:

- Liferay Digital Enterprise 7.0
- Sun Java 8 (1.8.0_65)
- Tomcat 8.0.32
- 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 DE. 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 DE'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 36,250 virtual users, we have a mean time (μ) of 378 ms and 95% of the logins (2σ) around 892 ms. The optimal performance point with relatively small standard deviation occurs somewhere around 36,000 virtual users.

At 36500 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 36,250 and 36,500 virtual users while stable performance and throughput is around 36,250 virtual users.

Virtual Users	Duration (min)	μ (ms)	σ (ms)	2σ (ms)	Login Throughput (TPS)	CPU Utilization (%)
32000	30	29.7	34	97.7	913	81
33000	30	38.2	54.7	147.6	940	85
34000	30	40.4	61.4	163.2	970	88
35000	30	72.6	96.5	265.6	993	93
36000	30	165	176	517	1000	95
36250	30	378	257	892	1020	95
36500	30	737	243	1223	1010	95
37000	30	890	282	1454	1010	95
38000	30	1450	214	1878	1010	95

Table 1 – Isolated Login

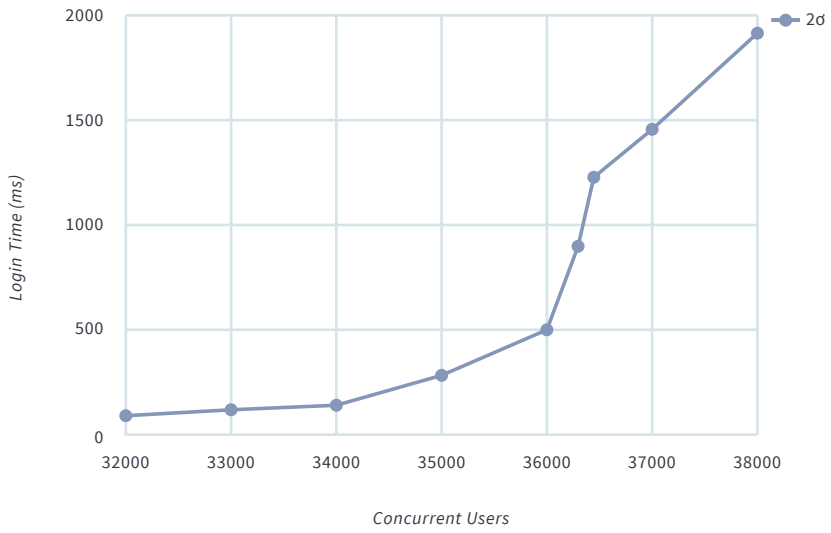

Figure 2: Mean Login Time

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

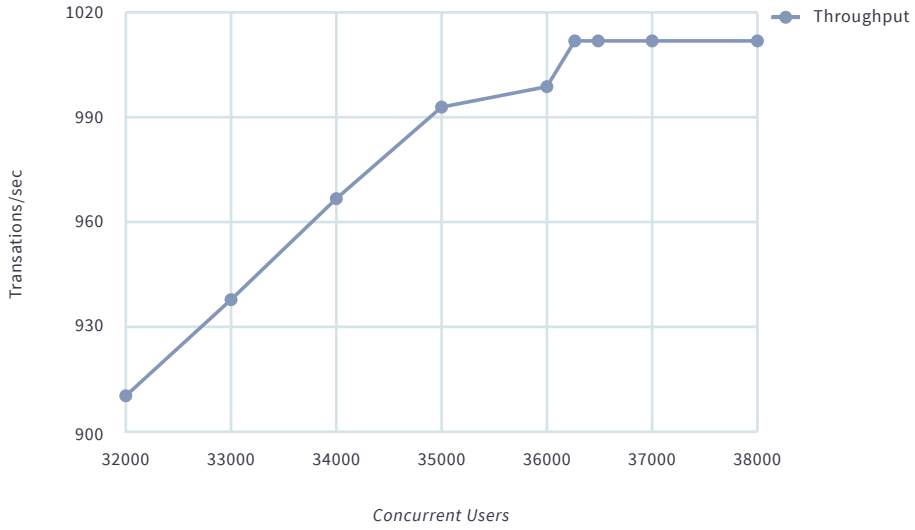

Figure 3: Isolated Login Throughput

Upon maxing out a single application server, a second portal application server was deployed. The benchmark results showed that Liferay Digital Enterprise was able to breach 72,500 virtual users using two application servers. At 72,500 users across two application servers, the performance characteristics remained identical to those gathered with 36,250 users on a single application server. The second Liferay Digital Enterprise 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 13,000 virtual users, 23,000 users less than the previous login scenario. At the inflection point, we see that 95% (2σ) of the combined login and homepage transactions consume 3.1s with a mean time of 2.4s.

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 (min)	Time Delayed Page μ (ms)	Time Delayed Page σ (ms)	Time Delayed Page 2σ (ms)	Throughput (TPS)	CPU (%)
9500	30	2100	134	2368	242	34
10500	30	2130	168	2466	267	39
11200	30	2170	212	2594	284	41
11400	30	2200	243	2686	288	42
11600	30	2270	309	2888	292	43
11800	30	2300	258	2816	297	43
12000	30	2340	348	3036	301	44
13000	30	2360	351	3062	326	49
14000	30	2490	466	3422	349	53
15000	30	2660	622	3904	370	57
16000	30	3280	1510	6300	375	59

Table 2 – Login with Simulator

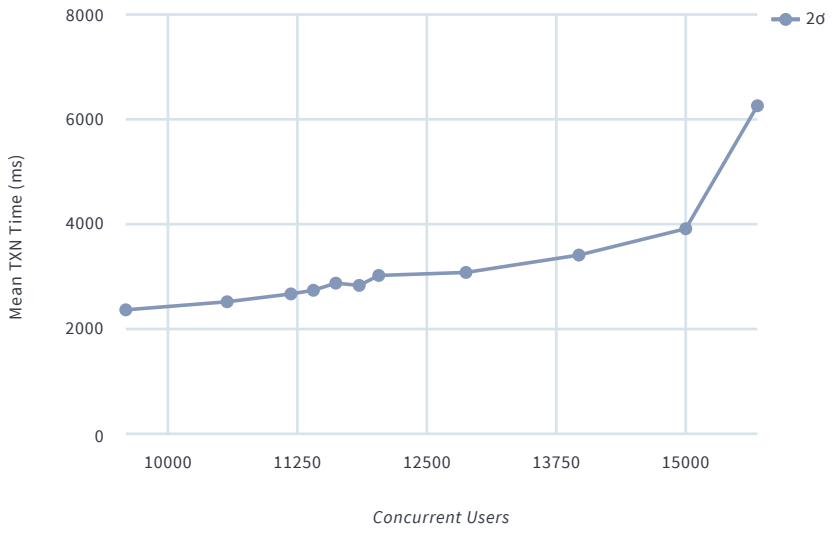

Figure 4: Legacy Login

Figure 4 illustrates Liferay Digital Enterprise approaching its optimal performance just above the 13,000 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 Digital Enterprise was able to breach 26,000 virtual users using two application servers. At 26,000 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 13,000 virtual users. At 13,500 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)
9000	30	25	18.1	58.2	21.3	47.8	29.7	100	29.1
10500	30	24.8	20.4	61.4	23.2	51.6	33.3	111	31.9
11000	30	27.9	34.5	67	37.6	57.3	44.9	121	49.8
11500	30	28.5	34	68.1	35.4	58.1	43.4	126	54.1
12000	30	32.2	46.9	75	45.5	65.8	57.9	135	66.4
12500	30	38.4	60.2	83.4	58.1	73.3	65.5	158	84.1
13000	30	50.7	98.3	96.4	85.2	84.6	91.9	181	118
13500	30	345	1220	266	795	238	763	391	792
14500	30	1030	2190	652	1450	536	1170	778	1430

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 (%)
9000	79	27.7	82.7	30.4	392.7	156.3	705.3	45
10500	86	30.9	89.8	32.4	424.6	172.1	768.8	52
11000	94.8	47.6	97.8	48.4	465.8	262.8	991.4	56
11500	96.6	46.6	101	51.2	478.3	264.7	1007.7	58
12000	107	65.2	111	62.8	526	344.7	1215.4	63
12500	119	78.9	124	80.9	596.1	427.7	1451.5	65
13000	135	105	144	111	691.7	609.4	1910.5	69
13500	360	890	411	1050	2011	5510	13031	64
14500	870	1630	1080	1970	4946	9840	24626	62

Table 5 – Message Boards Part 2

Figure 5 shows us that the optimal performance point at 13000 virtual users for a single JVM.

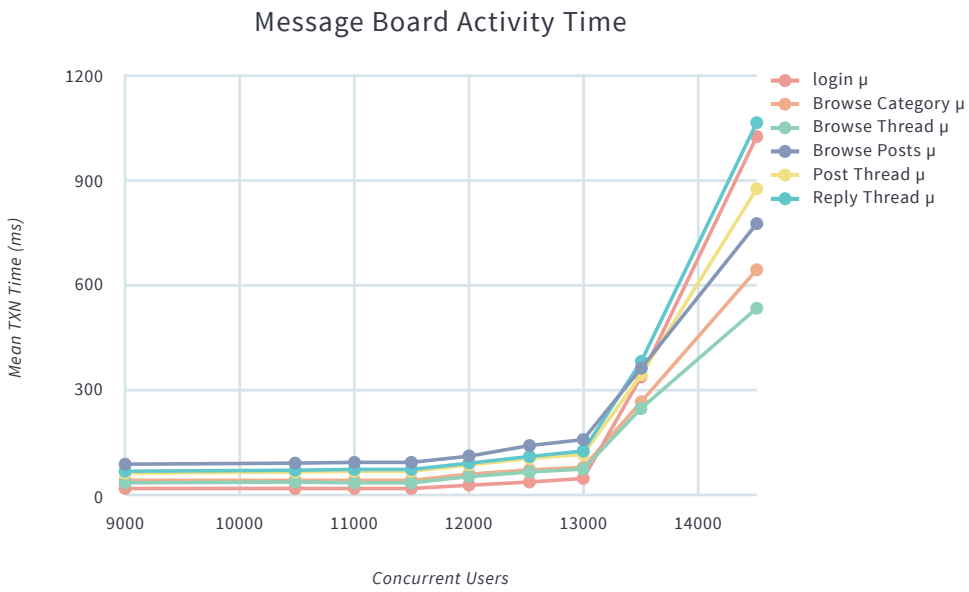

Figure 5: Collaboration Performance

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 9,000 virtual users. At this load, we observed total mean transaction times (µ) at 679.8ms with 95% of all transactions consuming roughly 1.6s. 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 178 ms and 211ms respectively.

Virtual Users	Duration (min)	Login Time μ(ms)	Login Time σ(ms)	View Summaries μ(ms)	View Summaries σ(ms)	View Entry μ(ms)	View Entry σ(ms)
5500	30	24.5	14.9	68.4	21.2	60.3	21.4
7000	30	25.4	22.3	77.9	28.7	64.9	27.5
8000	30	27.8	31.7	88.3	38.7	71.8	36.6
9000	30	51.8	87.8	130	76.6	109	79.6
9100	30	162	283	201	148	177	155
9200	30	407	722	336	402	289	399
9300	30	418	752	347	419	299	426
9500	30	1050	1340	738	686	614	694
9600	30	1080	1170	707	627	625	651
9800	30	1840	1670	1220	803	960	886
10000	30	1530	1430	996	725	809	779

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 (%)
5500	97.2	22.5	104	26	354.4	106	566.4	45
7000	109	34.6	117	34.8	394.2	147.9	690	58
8000	123	49.9	133	54.6	443.9	211.5	866.9	67
9000	178	109	211	139	679.8	492	1663.8	80
9100	287	245	341	291	1168	1122	3412	87
9200	434	520	527	660	1993	2703	7399	83
9300	4450	549	529	684	6043	2830	11703	84
9500	922	1040	1190	1300	4514	5060	14634	85
9800	1650	1450	1970	1560	7640	6369	20378	86

Table 7– Blogs Part 2

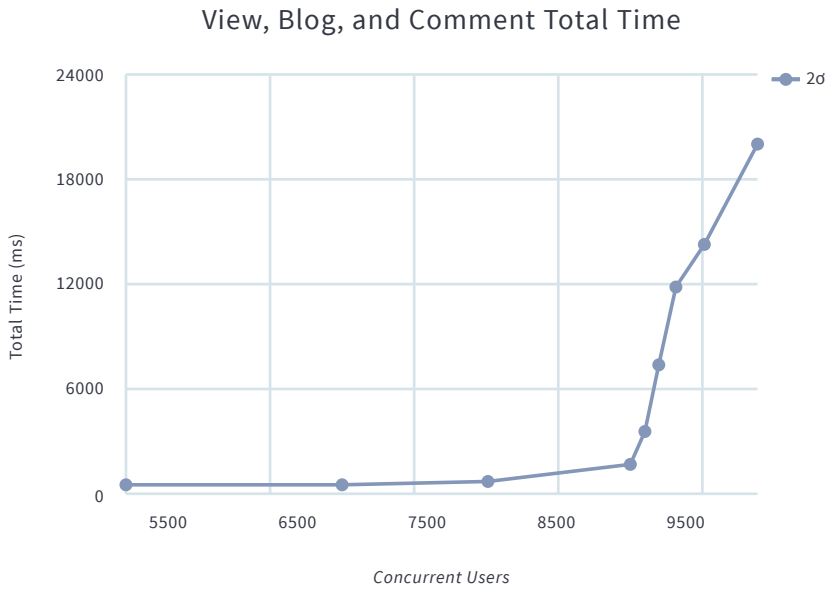

Figure 6: 95% Transaction Time for Blogging Test Case

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 1.6s at 9,000 users, from 867 ms at 8,000 virtual users. Based on the statistics, the most stable performance point is somewhere between 7,500 and 8,000 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), 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 18,000 users, 95% of file downloads occurred in 100ms for a 100KB document. Document upload times for a 100KB document with 19,000 virtual users remains under 1s, coming in at 880ms 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)
16000	30	95	62.9	50.4	51.4	10.8	41	166	87.2
17000	30	114	79.4	62	66.1	15.8	54.4	192	105
17500	30	128	90.4	70.9	74.2	20.9	61.3	215	126
18000	30	169	130	105	113	45.7	98.2	284	203
18500	30	259	213	177	195	111	181	433	375
19000	30	471	352	340	319	251	308	880	679
20000	30	989	739	561	607	607	650	1900	1470
21000	30	1220	610	983	592	955	627	2300	1170
22000	30	1800	423	1610	451	1570	423	3450	835

Table 8– Document Library

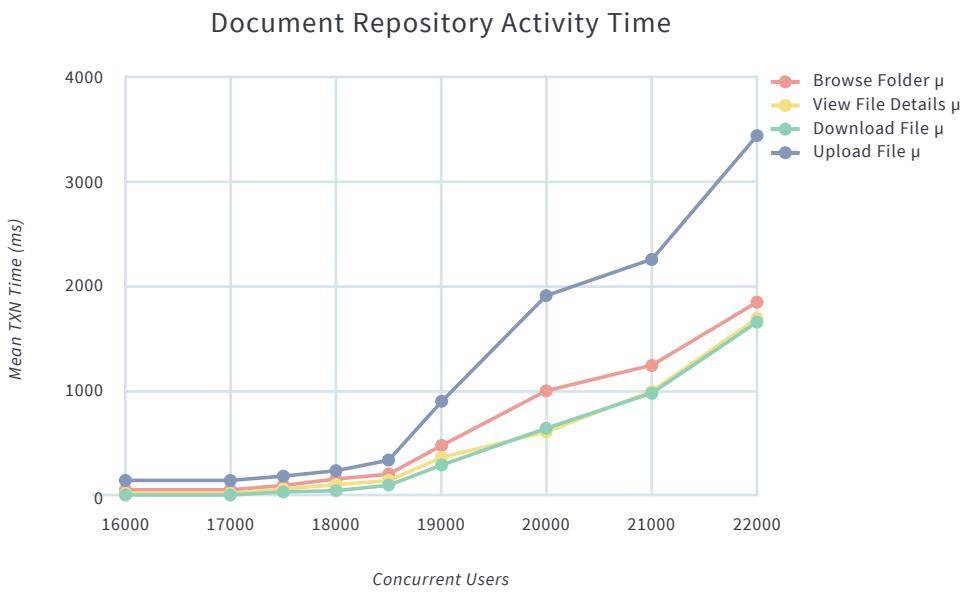

Figure 7– Document Repository Mean Time

Summary

Liferay Engineering, in collaboration with various clients and partners, commissioned this benchmark study to demonstrate the performance and scalability of Liferay Digital Enterprise 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 Digital Enterprise 7.0 and not Liferay Portal 7.0 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

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

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