LIFERAY PORTAL PERFORMANCE

BENCHMARK STUDY OF LIFERAY PORTAL 6.1 ENTERPRISE EDITION

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Liferay Portal Performance

Benchmark Study of Liferay Portal 6.1 Enterprise Edition

EXECUTIVE SUMMARY

Liferay Portal is the leading open source enterprise portal solution named by Gartner as a leader the Gartner Magic Quadrant (MQ) for its feature completeness and ROI among the vendors represented in the MQ. Liferay Portal Enterprise Edition (EE) is the commercially supported edition of Liferay Portal which contains improved performance, security, and other exclusive capabilities.

The Liferay engineering team performed intensive tuning and testing to demonstrate the scalability of Liferay Portal EE 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 Portal provides linear scalability (i.e. if we double the number of portal application servers, we should double the number of virtual users)
- Provide statistics to help Liferay Global Services, Liferay Portal EE clients, and Liferay Service Partners in capacity planning

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

- 1,000,000 total users
- 2,000,000 documents with an average of 100KB per document
- 10,000 sites
- 4,000,000 message forum threads and posts
- 100,000 blog entries and 1,000,000 comments
- 100,000 wiki pages

The key findings of the study are:

1. As an infrastructure portal, Liferay Portal can support over 27,000 virtual users on a single server with mean login times under 200ms and maximum throughput of 760+ logins per second
2. Liferay Portal's Document Repository easily supports 5,400 virtual users while accessing 2,000,000 documents in the document repository
3. Liferay Portal's WCM scales to beyond 300,000 virtual users on a single Liferay Portal server with average transaction times under 50ms and 35% CPU utilization
4. In collaboration and social networking scenarios, each physical server supports over 6000 virtual concurrent users at average transaction times of under 800ms
5. Given sufficient database resources and efficient load balancing, Liferay Portal can scale linearly as one adds additional servers to a cluster

TEST SCENARIO

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 transaction like online banking (bill payments, etc), online insurance applications, airline and hotel booking, and etc
  - 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 LPEE support matrix for additional platforms)
3. Database Tier – Hosts Liferay supported database servers like MySQL, Oracle, MS SQL, IBM DB2, Postgres (please see LPEE support matrix for additional platforms)

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

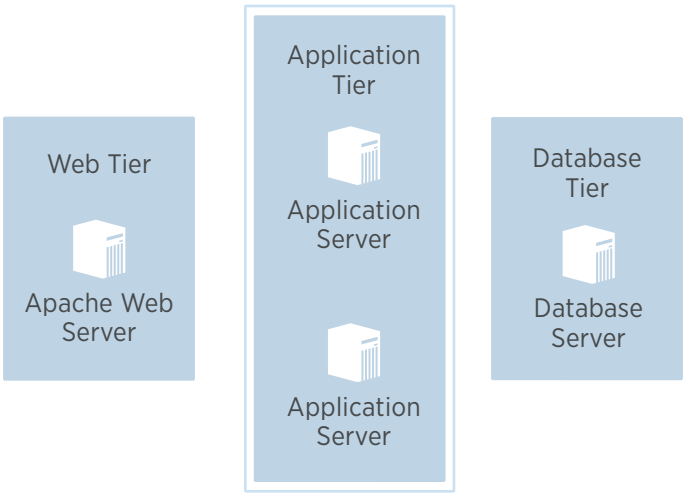

Figure 1 - Benchmark Configuration

Hardware platforms:

1. Web Server
   - 1 x Intel Core 2 Duo E6405 2.13GHz CPU, 2MB L2 cache (2 cores total)
   - 4GB memory, 1 x 146GB 7.2k RPM IDE
2. Application Server
   - 2 x Intel Core 2 Quad X5677 3.46GHz CPU, 12MB L2 cache (8 cores and 16 threads)
   - 16GB memory, 2 x 146GB 10k RPM SCSI
3. Database Tier
   - 2 x Intel Core 2 Quad X5677 3.46GHz CPU, 12MB L2 cache (8 cores and 16 threads)
   - 16GB memory, 4 x 146GB 15k RPM SCSI

Network:

- Gigabit network between all servers and test clients

Software:

- Liferay Portal 6.1 Enterprise Edition
- Sun Java 6 (1.6.0_31)
- Tomcat 7.0.26
- CentOS 5.5 64-bit Linux
- MySQL 5.5 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 5 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 scenario focuses on the login process of Liferay Portal. 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'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 200ms as we approach the performance inflection point. At 23000 virtual users, we have a mean time (μ) of 121ms and 95% of the logins (2σ) around 663ms. The optimal performance point with relatively small standard deviation occurs somewhere between 23000 virtual users.

At 26000 virtual users, we exceed the established performance budget of this test (i.e. sub 1 second login times). However, performance has not degraded excessively. At 29000, the system breaches into unacceptable performance territory. Thus, the performance inflection point for login is roughly between 27000 and 29000 virtual users.

VIRTUAL USERS	DURATION (min)	μ(ms)	σ (ms)	2σ (ms)	THROUGHPUT (TPS)	CPU UTILIZATION (%)
14000	30	38.8	18.8	76.4	399	77
18000	30	111	193	189	511	78
21000	30	114	243	278	567	85
23000	30	121	271	663	652	85
26000	30	199	443	1085	734	87
27000	30	210	412	1034	764	88
29000	30	2320	1530	5380	548	88

Table 1 - Isolated Login

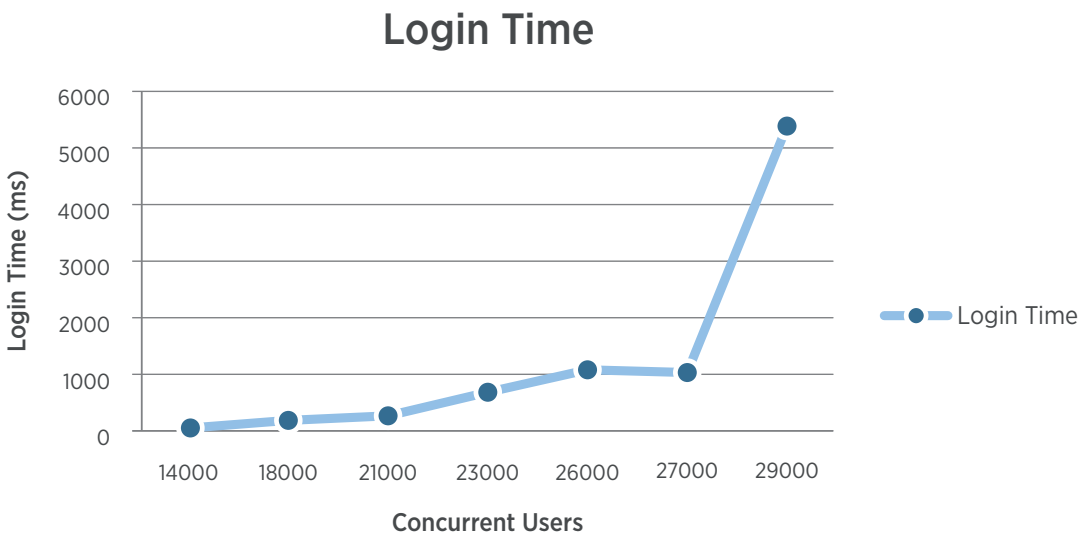

Figure 2: Mean Login Time

In terms of throughput, the portal appears to have an optimal throughput of roughly 730 transactions per second.

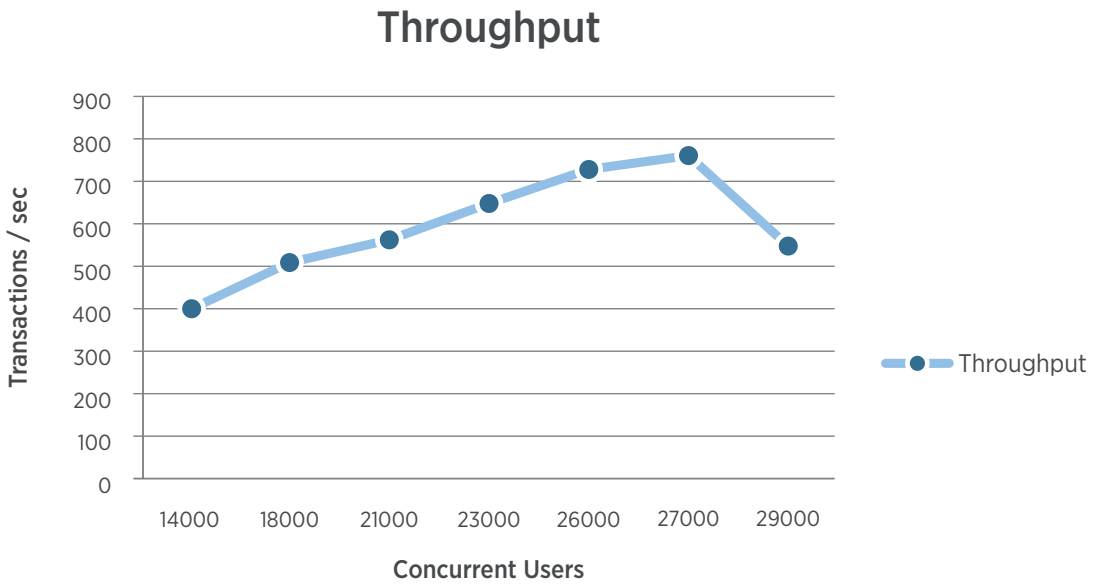

Figure 3: Isolated Login Throughput

Upon maxing out a single application server, a second portal application server was deployed. The benchmark results showed that Liferay Portal was able to breach 54,000 virtual users using two application servers. At 54,000 users across two application servers, the performance characteristics remained identical to those gathered with 27000 users on a single application 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 6300 virtual users, 20700 users less than the previouslogin scenario. At the inflection point, we see that 95% (2σ) of the combined login and homepage transactions consume 2.6s with a mean time of 2.2s.

VIRTUAL USERS	DURATION (min)	TIME DELAYED PAGE μ(ms)	TIME DELAYED PAGE σ(ms)	TIME DELAYED PAGE 2σ(ms)	THROUGHPUT (TPS)	CPU (%)
3000	30	2050	28.1	2106.2	76.7	23
4200	30	2070	47.5	2165	107	33
5400	30	2100	115	2330	138	47
6300	30	2200	243	2686	160	60
6400	30	2650	2660	7970	158	61

Table 2 - Login with Simulator

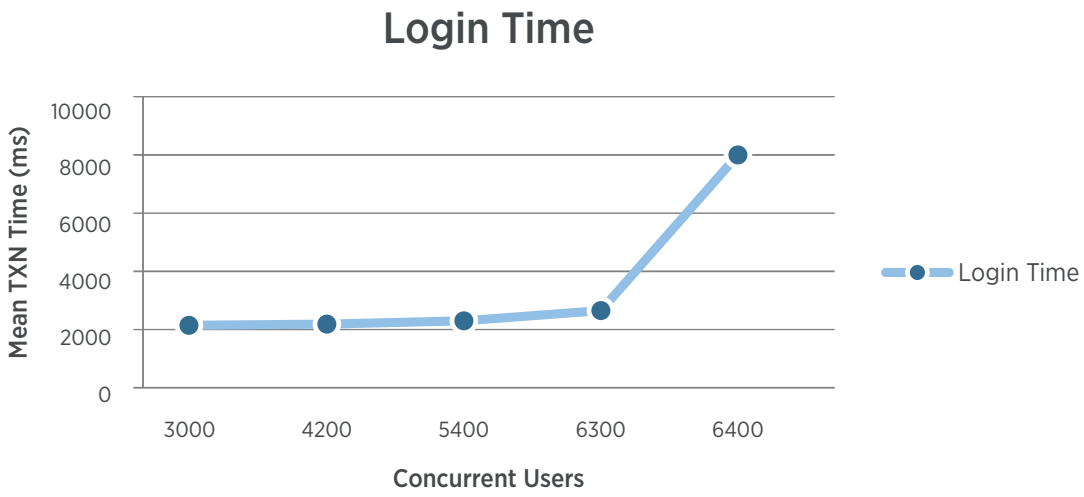

Figure 4: Legacy Login

Figure 4 illustrates Liferay Portal approaching its optimal performance just above the 6300 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 Portal was able to breach 12600 virtual users using two application servers. At 12600 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 demonstrates 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 5800 virtual users. At 6200 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)
3400	30	35.4	10.6	120	14.2	63.9	31.7	164	25.7
4200	30	37.7	12.3	133	19.1	69.8	34.9	182	31.2
5000	30	41.8	16.7	150	28.1	78.2	40.1	202	39.4
5800	30	61	32.2	201	58.6	104	60.8	250	61.7
6200	30	84	80.5	257	117	138	97.6	311	111
6400	30	156	220	322	176	178	154	377	177

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 (%)
3400	86.3	11.4	98.4	17.1	568	110.7	789.4	36
4200	92.5	14.8	107	20.9	622	133.2	133.2	48
5000	104	22.6	122	30.1	698	177	1052	59
5800	141	52.1	161	57.6	918	323	1564	75
6200	193	118	218	126	1201	650.1	2501.2	76
6400	273	226	300	229	1606	1504	4614	78

Table 5 - Message Boards Part 2

Figure 5 shows us that the optimal performance point at 3300 virtual users for a single JVM.

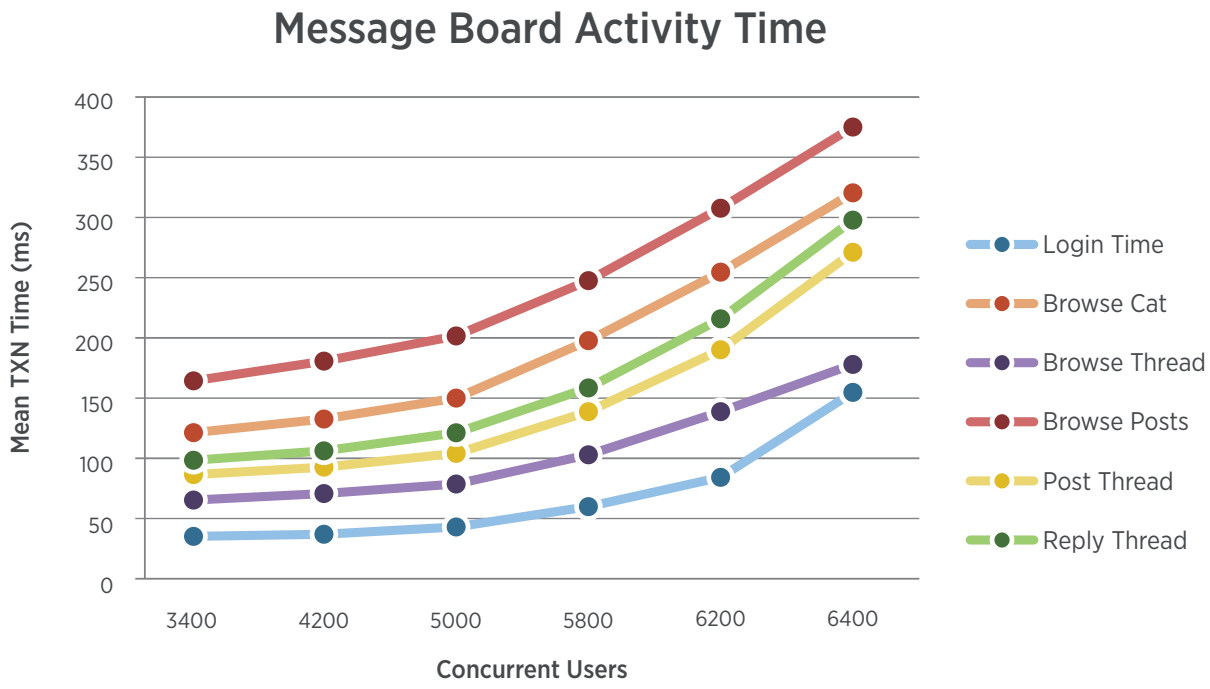

Figure 5: Collaboration Performance

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 6000 virtual users. At this load, we observed total mean transaction times (μ) at 540.8ms with 95% of all transactions consuming roughly 1.0s. 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 250ms and 319ms 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)	POST NEW ENTRY μ(ms)	POST NEW ENTRY σ(ms)
5200	30	38.8	18.2	65.9	23.6	82	22.2	119	30.2
5600	30	44.6	23.1	74.7	30	91.6	27.1	134	40.9
6000	30	57.1	39.5	96.7	52.2	108	43.9	168	75.7
6400	30	107	140	146	122	147	96.1	222	161

Table 6 - Blogs Part 1

VIRTUAL USERS	POST COMMENT μ(ms)	POST COMMENT σ(ms)	TOTAL μ(ms)	TOTAL σ(ms)	TOTAL 2σ(ms)	CPU (%)
5200	105	26.4	410.7	111.4	633.5	64
5600	117	32.8	461.9	153.9	769.7	70
6000	141	54.9	540.8	266.2	1073.2	77
6400	187	136	809	655.1	2119.2	77

Table 7 - Blogs Part 2

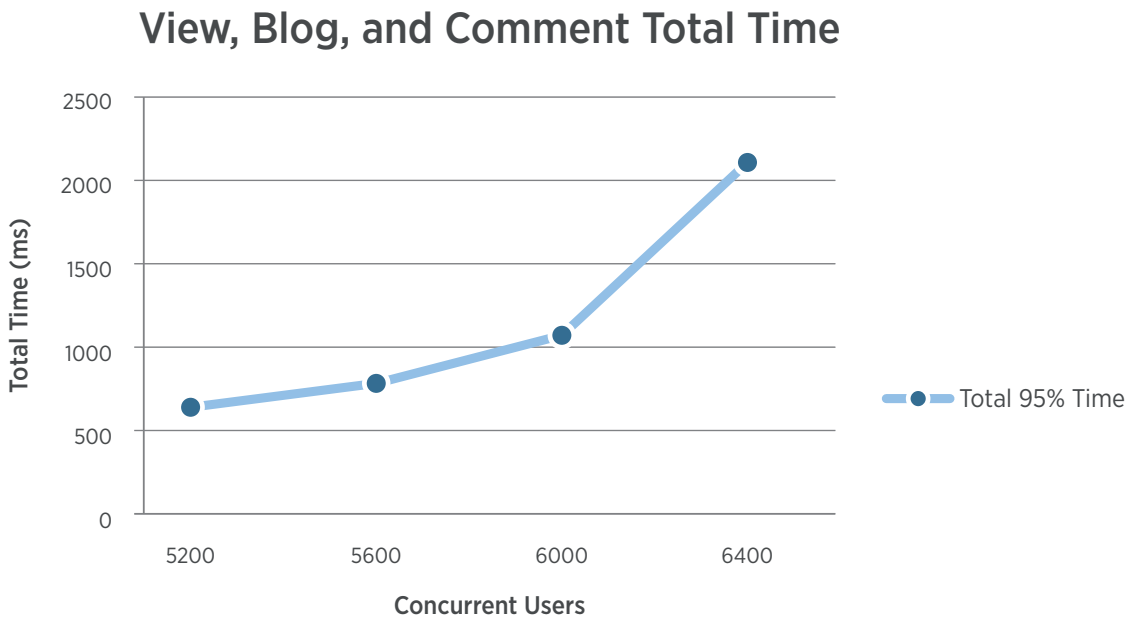

Figure 6: 95% Transaction Time for Blogging Test Case

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 2.1s at 6400 users, from 1.0s at 6000 virtual users. While for many customers, 2.1s for an entire test case of 5 transactions is perfectly acceptable performance, the underlying performance numbers indicate the system has begun exhibiting queuing behaviors.

CONTENT AND DOCUMENT MANAGEMENT SCENARIOS

Liferay provides rich capabilities for both web content management and document management. The product supports document management features via the document and media gallery. The gallery is backed by a full featured content repository that supports multi-level workflow approvals, custom document metadata definitions, and social collaboration features (e.g. ratings, comments, etc).

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 (1Gbps).

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 5400 users, 95% of file downloads occurred in 316ms for a 100KB document. Document upload times for a 100KB document with 5400 virtual users remains under 500ms, coming in at 406ms 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)
3500	30	227	59.8	68.5	59.2	28.8	79.4	125	35.3
4000	30	245	30.5	71	14.4	31.6	83.6	131	26.9
4600	30	274	43.6	80.1	19.4	36.2	101	150	40.7
5200	30	318	79.1	95.4	32.4	41.9	14.9	175	50.7
5400	30	412	148	124	61.3	58.1	129	222	92
5500	30	769	487	302	334	196	311	446	378

Table 8 - Document Library

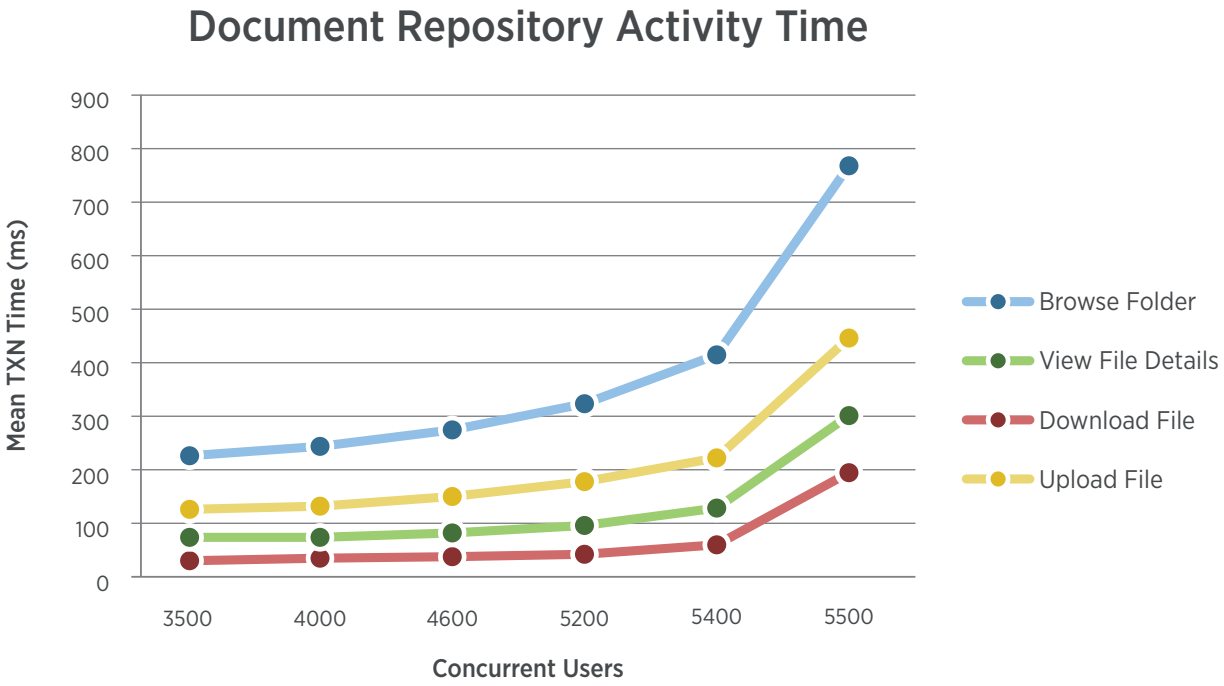

Figure 7 - Document Repository Mean Time

SUMMARY

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

Based on the results of this study, Liferay determined that the Liferay Portal 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 the Liferay Portal platform is uniquely positioned to help bring Web 2.0 capabilities to the enterprise.

Due to the many performance enhancements introduced in the enterprise edition, the benchmarks apply to Liferay Portal 6.1 EE and not to 6.1 CE. This approach ensures that Liferay's EE 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 the Liferay customer network for their contributions in helping develop performance test cases. Liferay would also like to thank the Liferay Portal Open Source Community for their important contributions in performing independent benchmarking and testing.

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