Liferay Portal Performance

BENCHMARK STUDY OF
LIFERAY PORTAL ENTERPRISE EDITION

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Executive Summary

Liferay Portal is the leading open source enterprise portal solution. Gartner name Liferay a leader in feature completeness and ROI among the vendors represented in the Gartner Magic Quadrant. Liferay Portal Enterprise Edition is the commercial and long-term supported edition of the Liferay Portal solution.

The Liferay engineering team performed intensive tuning and testing to demonstrate the scalability of Liferay Portal Enterprise Edition 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 Enterprise clients, and Liferay Service Partners in capacity planning.

To truly achieve "enterprise scale," this study was commissioned with:

- 1,000,000 total users
- 4,000,000 message forum threads and posts
- 10,000 communities and organizations
- 100,000 blog entries and 1,000,000 comments

The key findings of the study are:

1. As an infrastructure portal, Liferay Portal can support over 11000 virtual concurrent users on a single server with mean login times under ½ a second and maximum throughput of 300+ logins per second.
2. In collaboration and social networking scenarios, each physical server supports over 5000 virtual concurrent users at average transaction times of under 800ms.
3. Liferay Portal's WCM scales to beyond 150,000 concurrent users on a single Liferay Portal server with average transaction times under 50ms and 35% CPU utilization.
4. Given sufficient database resources and efficient load balancing, Liferay Portal can scale linearly as one adds additional servers to a cluster.

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
  - Applies to financial, insurance, and e-commerce 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.
- Informational or content centric scenarios
  - Applies to publications (e.g. newspapers and magazines), product marketing, and e-government use cases.
  - Both anonymous and authenticated access to services provided by Liferay WCM. Session times will vary in duration.
- Collaboration centric scenarios
  - Applies to Facebook-like social networks and developer communities.
  - Also applies to corporate intranets as organizations begin to more heavily utilize Web 2.0 tools like blogs, wikis, and forums are part of employee collaboration.
  - Mostly authenticated access; roughly 5:1 ratio between read and write transactions.

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. Also provides integration modules to single sign-on solutions like CA Netegrity, Sun Identity, Oracle Identity, etc
2. Application Tier – hosts Liferay supported application servers like Tomcat, JBoss, Glassfish, Oracle AS, Oracle/BEA 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.

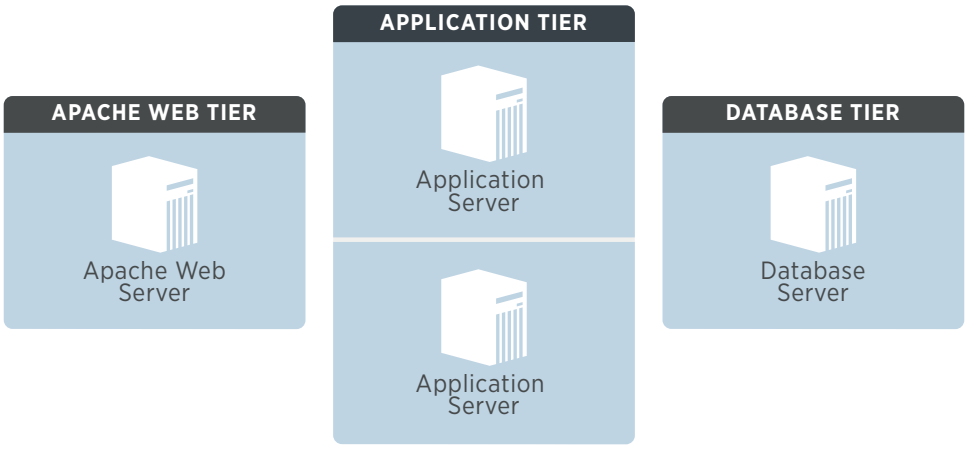

Figure 1 - Benchmark Configuration

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 E5540 2.53GHz 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 E5540 2.53GHz 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 6.0 Enterprise Edition
- Sun Java 6 (1.6.0_20)
- CentOS 5.2 64-bit Linux (kernel 2.6.18-92.1.22.el5 #1 SMP)
- MySQL 5.1.51 Community Server
- Apache HTTPD Server 2.2.16
- 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.

Although the benchmark environment consisted of two application servers, a single application server was used to perform most tests. Once the tests determine the max performance of a single server, Liferay utilized the second application server to prove the linear scalability hypothesis: that doubling the available application server hardware will double the maximum concurrent supportable user load.

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 11700 virtual users, we have a mean time (μ) of 134ms and 95% of the logins (2σ) around 700ms. The optimal performance point for this test scenario occurs somewhere between 11700 to 12000 virtual users. At 12000 virtual users, we see 2σ increasing to over 6s, moving substantially above the acceptable threshold. At this inflection point, we see CPU utilization at roughly 82% on the application server.

VIRTUAL USERS	DURATION (MIN)	μ (MS)	σ (MS)	2σ (MS)	THROUGHPUT (TPS)	CPU UTILIZATION (%)
3,000	30	75	44.2	163.4	72.6	25
5,000	30	79	55	189	121	40
7,000	30	82	74	230	168	51
8,000	30	102	278	278	194	58
9,000	30	144	383	383	220	63
11,000	30	161	430	430	299	79
11,700	30	286	706	706	314	80
12,000	30	296	6,096	6,096	318	82

Table 1 – Isolated Login

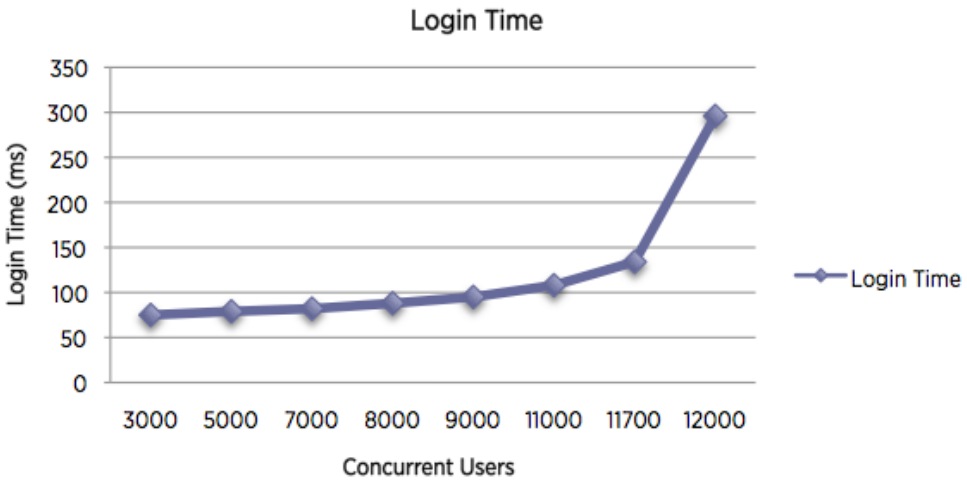

Figure 2: Mean Login Time

In terms of throughput, the portal appears to have an optimal throughput of roughly 314 transactions per second; the optimal throughput (at 11,700 concurrent users) is roughly 314 logins per second.

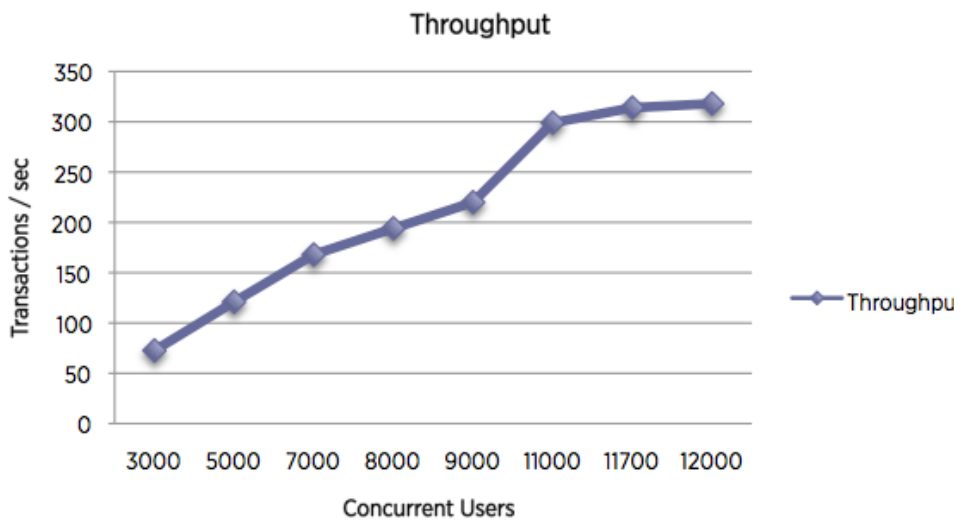

Figure 3: Isolated Login Throughput

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 23,400 concurrent users using two application servers. At 23,400 users across two application servers, the performance characteristics remained identical to those gathered with 11700 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 9100 virtual users, 2600 users less than the previous login scenario. At the inflection point, we see that 95% (2σ) of the combined login and homepage transactions consume 2.6s with a mean time of 2.2s.

VIRTUAL USERS TOTAL	DURATION (MIN)	LOGIN TIME μ (MS)	LOGIN TIME σ (MS)	DELAY PAGE μ (MS)	DELAY PAGE σ (MS)	TOTAL μ (MS)	TOTAL σ (MS)	TOTAL 2σ (MS)	THROUGHPUT (TPS)	CPU (%)
4000	30	77	49	2,026	33	2,103	82	2,267	77	37
5,000	30	81	62	2,024	45	2,105	107	2,319	90	49
6,000	30	102	94	2,040	54.3	2,142	148.3	2,438.6	108	56
8,000	30	144	114	2,060	76.5	2,204	190.5	2,585	144	65
9,100	30	177	221	2,150	204	2,327	425	3,177	160	77
9,300	30	204	398	2,240	277	2,444	675	3,794	172	83

Table 2 – Login with Simulator

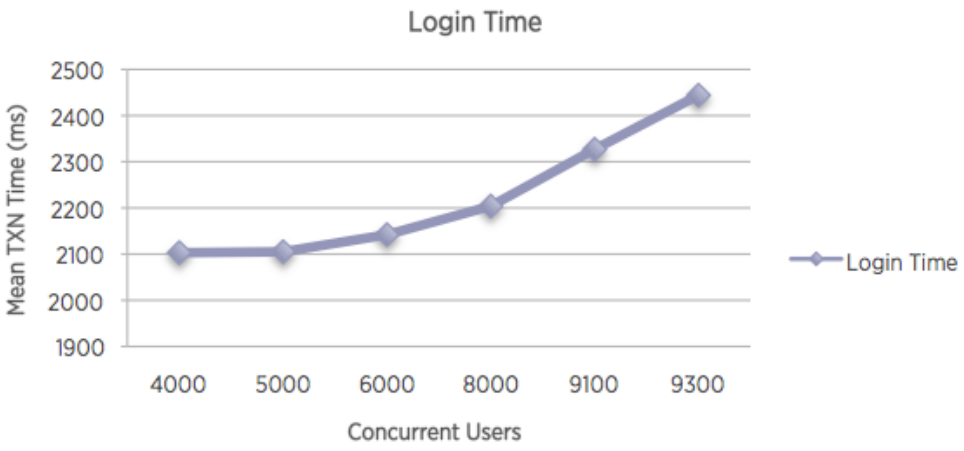

Figure 4:Legacy Login

Figure 4 illustrates Liferay Portal approaching its optimal performance just above the 9100 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 18200 virtual users using two application servers. At 18200 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.

CONTENT CENTRIC SCENARIOS

ANONYMOUS CONTENT

During tests, Liferay Portal WCM was able to service over 150,000 users browsing for content anonymously. The tests show the WCM handling the load with ease, using only 35% of a single server's resources. As shown in Table 2, at 150,000 users, the 95% of the transactions (2σ) remains comfortably below 50ms while the system only consumes 34% of total processing power. At the 150,000 user mark, the benchmark environment's network becomes a bottleneck as the gigabit network strains to keep up with the volume of requests.

Total throughput appears to remain constant at roughly 3900 transactions per second. Based on this statistic, it appears we have reached the maximum throughput of a single JVM hosting Liferay Portal. Since we have sufficient CPU resources, to achieve higher throughput, we should instantiate a second JVM on the same physical server.

VIRTUAL USERS	DURATION (MIN)	μ (MS)	σ (MS)	2σ (MS)	THROUGHPUT (TPS)	CPU (%)
25,000	30	.82	2.97	6.76	3,960	22
50,000	30	1.95	8.96	19.87	3,880	25
100,000	30	2.47	12.4	27.27	3,930	28
150,000	30	3.98	19.2	42.38	3,970	32

Table 3 – Browsing for Content Anonymously

Due to the test reaching maximum network bandwidth, Liferay deemed it unnecessary to proceed with allocating a second physical server to test linear scalability.

COLLABORATION SCENARIOS

MESSAGE BOARDS

Due to the complexity of the scenario, we have opted to start with lower initial concurrent user counts in our hunt for the performance inflection point. 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 1s when we have roughly 3300 virtual users. At 3600 users, we see that the system has exceeded 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)
2,700	30	71	37	127	56	222	77	198	70
3,000	30	87	49	155	77	275	113	241	101
3,300	30	116	83	200	130	354	184	307	168
3,600	30	384	2,490	541	2,970	1,040	4,240	794	3,530

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 (%)
2,700	288	99	274	95	1,180	435	2,050	61
3,000	354	132	342	135	1,454	609	2,672	71
3,300	455	220	444	218	1,876	1,052	3,980	77
3,600	1,180	4,210	1,130	3,980	5,069	21,420	47,909	78

Table 5 – Message Boards Part 2

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

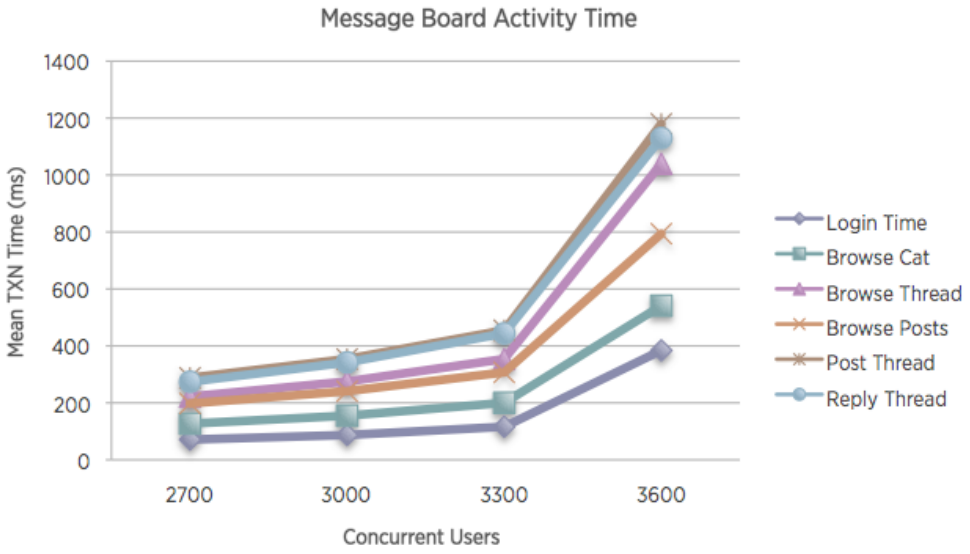

Figure 5: Collaboration Performance

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

BLOGGING

As with the message board scenarios, we chose to start the blogging scenarios with lower concurrent user counts due to its complexity. 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 reported in Tables 6 and 7, the statistics point to a performance inflection point of roughly 5400 virtual users. At this load, we observed total mean transaction times (μ) at 568ms with 95% of all transactions consuming roughly 2.1s. 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 521ms and 627ms 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)
5,100	30	116	73	158	92	150	83	273	143
5,400	30	130	85	172	99	162	94	307	160
5,700	30	217	338	162	249	243	259	476	468
6,000	30	1100	2,460	805	2,050	775	2,000	1,440	2,330

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 (%)
5,100	237	120	934	510	1,954	78
5,400	261	130	1,032	568	2,168	79
5,700	401	321	1,599	1,635	4,869	81
6,000	1,230	2,400	5,350	11,240	27,830	82

Table 7 – Blogs Part 2

Figure 6 depicts the total mean transaction time as the system approaches the optimal performance point. From the Table 8, we see total mean transaction time moving to 4.8s at 5700 users, from 2.1s at 5400 virtual users.

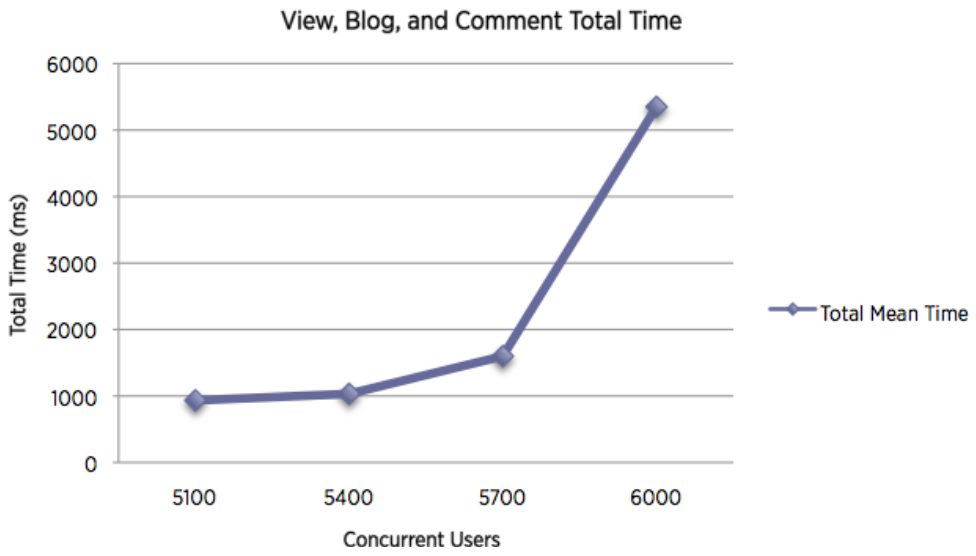

Figure 6: Mean Blogging Transaction Time

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 now 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 6.0 EE and not to 6.0 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 standard 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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