

## Benchmark Study of Tolven Healthcare Solution

### Introduction

This benchmarking exercise was undertaken by Tolven Inc. in conjunction with Sun Microsystems between November 2007 and February 2008. The purpose of this benchmarking exercise was to assess the scalability and performance characteristics of the Tolven open source healthcare information technology solution and to provide guidance for customers with regards to hardware requirements for enterprise, state, regional, and country wide deployments. The benchmarking exercise was undertaken using the following technologies hosted in the Sun benchmarking center:

Hardware	Software
Sun Fire™ X4600 M2	Solaris 10
8 Dual core 64-bit CPUs	Sun ZFS file system
32GB RAM	JBoss
Sun Storage Tek 2540 Array	PostgreSQL
12x146GB Disks, 15K RPM	Sun Directory Server

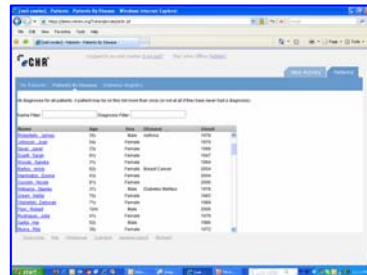
### Testing Scenario

The testing scenario used for the benchmark exercise emulated 200 simultaneous users logging in, selecting a patient, viewing a patient's summary, drilling down to a specific result, pausing for 10 seconds and then logging out. The number of users was adjusted during different runs to find a balance between throughput (number of scenarios completed in a given period of time) and end user response time.

During the execution of the interactive testing scenario, a background message load of 333 Continuity of Care Record (CCR) transactions per minute was applied to the system. The CCR transactions contain patient demographics and 12 years of patient activity, including medications, problems, results and appointments. The background transaction rate used during the user simulation was chosen as representative of the kind of peak message load that might be expected in a system of this size.



Apache JMeter was used to generate the CCR transactions and control the execution of the scenarios. All transactions generated used HTTPS, and the connections between the application server, database and directory server all used SSL. The CCR documents generated were encrypted, Tolven decrypted the documents, indexed the data and then re-encrypted the document in the destination account. The overall average response time for the scenario was 250ms. The following table lists each step in the scenario and the average response time.



Activity	Description	Think time	Avg (ms)
Display Login	Display the login page	n/a	49
User Login	User supplies User name and password	1 sec	157
Account Login	User selects among multiple accounts (e.g., a physician selects which hospital account they wish to log into or their own clinic)	1 sec	524
Select Patient	The user selects a patient from a list of 10,000 patients in the selected account	1 sec	639
Select Results	User views a 9-panel patient summary, and then selects the results tab	1 sec	168
Select Lab Tab	User selects the lab results tab and views the results	10 sec	175
Logout	User logs out	n/a	36

At the conclusion of the benchmark, a total of 3,278,899 patients had been added to the system. The average patient had about 150 index entries in the database including medications, results, appointments and problems. During the benchmarking exercise, the total database size peaked at 474GB or 60% of the available space on the 2540 disk array. The largest table grew to 502,261,521 rows.

### Findings

Throughput was based on the number of scenarios completed in a given unit of time: 2,219 scenarios completed in 200 seconds or 11.095 scenarios per second. This number is used in the calculated results shown in the table below.

Duration	End-user Scenarios Completed	CCR Messages Processed
1 minute	666	333
5 minutes	3,328	1,666
10 minute	6,657	3,333
30 Minutes	19,971	10,000
60 minutes	39,942	20,000
8 hrs	319,536	160,000

## Summary

In most cases, throughput numbers are used to measure peak volumes. For example, a hospital might want to ensure that response time is good during a one hour interval in the morning when many attending physicians are rounding. *The hospital will realize that the system is underutilized for the remaining 23 hours of the day.*

In addition, the simulated workloads do not accurately represent real-world workloads because:

- Network latency can vary widely from the relatively sterile simulation of the test environment, and real users on a wide area network are likely to experience slower response times. For this reason, average response time in the testing scenarios was kept to approximately ¼ second to allow for real-world network delays.
- The simulation driver, JMeter, does not actually emulate all of the capability of a web browser. Therefore, response times were actually longer using the emulator than when measured using a real browser because JMeter executes each AJAX query synchronously. This differentiation in performance was particularly noticeable when the overview information was acquired as it involved nine different portlets, each one representing a separate HTTP request.

## Conclusion

The benchmarking exercise evidenced that Tolven, the Sun Fire™ X4600 M2 environment and the associated open source technologies used for this are highly scalable, as well as economical: The cost of the hardware used for this benchmarking exercise was in the region of \$40,000. Based on the usage model described in this benchmarking exercise, this hardware environment would support large scale deployments of the Tolven electronic personal and clinician health record in regional or enterprise environments.

*Tolven would like to acknowledge Sun Microsystems for their support in assisting with this benchmarking exercise and for making the test environment available for the duration of this process.*

**For further information about Tolven or this benchmarking exercise, please contact Tolven at [info@tolvenhealth.com](mailto:info@tolvenhealth.com)**

**For further information about Sun Microsystems visit [www.sun.com](http://www.sun.com)**

### Tolven Incorporated

[www.tolvenhealth.com](http://www.tolvenhealth.com) and [www.tolven.org](http://www.tolven.org)

500 Washington Street, Suite 325

San Francisco, CA 94111 USA

TEL: +1 707.939.7845 or eMail: [info@tolvenhealth.com](mailto:info@tolvenhealth.com)