

# Sequor Systems

Date: May 2016 Author: Brian Garrett, VP ESG Lab

## Abstract

This ESG Lab Review explores performance improvements of up to 700% that can be achieved with patented non-blocking synchronization technology in a web server and software development kit (SDK) from Sequor Systems.

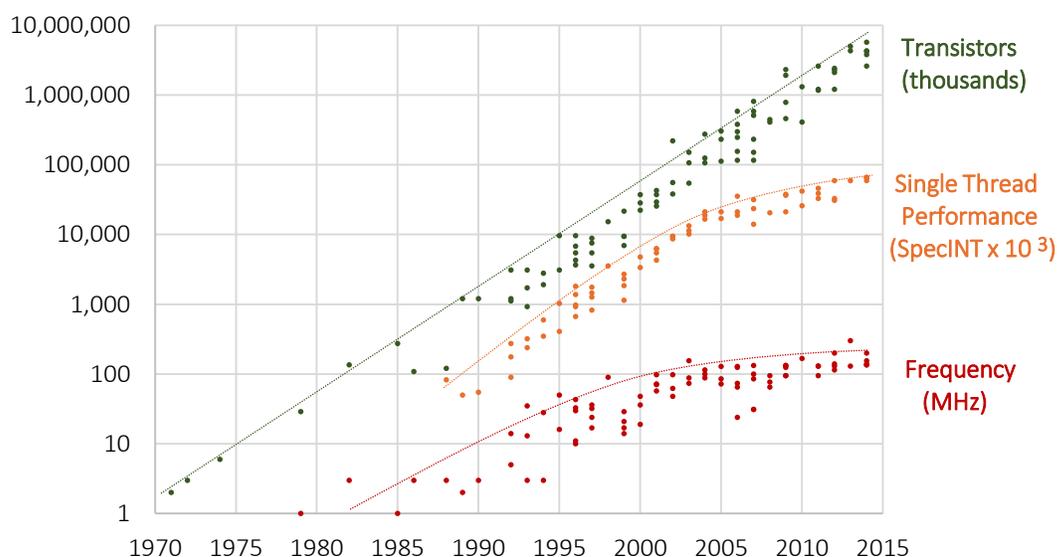
## Background

Moore's law has run into a bit of a speed bump in recent years. As shown in Figure 1, Gordon Moore's famous prediction that microprocessor transistor counts will double every 18 to 24 months has held true for more than 40 years.<sup>2</sup> Processor clock speeds increased at roughly the same trajectory until the mid-90s when exploding power and cooling requirements

Hyper-threading and multi-core processors entered the mainstream after Intel engineers predicted in 1999 that if single core processor trends were to continue, by 2010 they'd burn as hot as the surface of the sun.<sup>1</sup>

drove the adoption of multi core processors. While increasing the number of cores running at the same frequency avoided a power and cooling meltdown, it also led to a reduction in application performance improvements. IT infrastructure managers can no longer assume that applications will run faster on the latest processors. This phenomenon, which has been aptly referred to as "the free lunch is over," is driving the biggest sea change in software development since the object-oriented revolution.<sup>3</sup>

Figure 1. Forty Years of Microprocessor Trend Data



Source: Enterprise Strategy Group, 2016

<sup>1</sup> Samuel K. Moore, [Multi-core CPUs: Processor Proliferation](#), January 2011.

<sup>2</sup> Karl Rupp, [Forty Years of Microprocessor Trend Data](#), June 2015.

<sup>3</sup> Herb Sutter, [The Free Lunch is Over](#), Dr. Dobbs' Journal, 30(3), March 2005.

## The Challenges

Harnessing the performance benefits of Moore's Law has become a challenge in recent years, especially for concurrent workloads with many users or threads that are executing in parallel (e.g., a web server). As a result, servers that are running the busiest concurrent workloads in the data center are often underutilized. Underutilization increases costs as more servers need to be purchased, deployed, powered, cooled, and managed.

Concurrent programming technologies were born decades ago for use in real-time systems and high-performance computing. Concurrent programming coordinates access to shared resources by multiple instances of a program operating in parallel. Traditionally, locks were used to coordinate access to critical regions of code with constructs including semaphores and mutexes. Traditional locking is notoriously difficult to implement and debug due to subtle interaction issues (e.g., race conditions, deadlocks, priority inversions). Besides being hard to implement and debug, traditional locking methods can lead to unpredictably slow and buggy applications.

Lock-free programming is the name for a relatively new computer science discipline that's being used to improve the performance and reliability of concurrent workloads. Lock-free programming guarantees that a failure or suspension of one thread will not cause another thread to fail or be suspended. The first wave of lock-free programming methods relied heavily on compare and swap primitives that can have some of the same complications and side effects as traditional locking methods. The latest wave in lock-free programming is being fueled by state of the art innovations in lock-free synchronization.

## The Solution

Sequor Systems uses patented lock-free synchronization technology to improve the performance, scalability, and efficiency of concurrent application workloads.<sup>4</sup> Sequor Systems technology is available today within a production-ready Linux web server or a software development kit (SDK) that can be used to improve the performance and reliability of existing or planned applications.

Sequor Systems' patented data structures and algorithms minimize the latencies associated with traditional synchronization methods, which frees up CPU cycles for better application throughput. While the technology inside Sequor Systems is sophisticated, the web server and SDK mask the complexities of lock-free synchronization. A few of the many advantages of this novel approach include:

- Dramatically better application performance.
- Higher server utilization.
- Lower energy and cooling requirements.
- Better application scalability.
- Better application stability.
- Lower capital equipment expenses (CapEx).
- Lower operational expenses (OpEx).

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<sup>4</sup> [US Patent 8,793,284](#); Inventor: Mr. Laurie Dean Perrin.

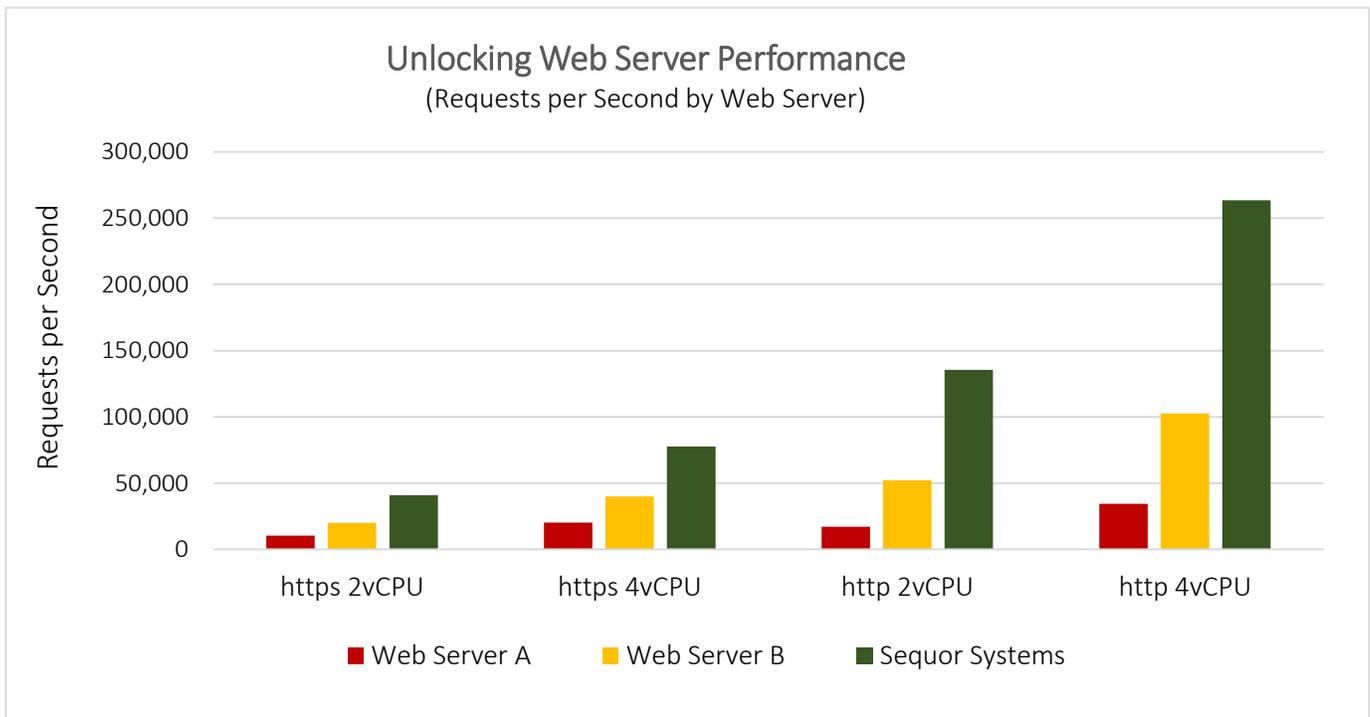
## ESG Lab Review

Web server benchmark tests were run with a goal of quantifying the performance gains that can be achieved with Sequor Systems non-blocking synchronization technology. Tests were run within Linux virtual machines that were hosted at a Green House Data co-location facility. Green House Data is a highly available cloud hosting and colocation service provider with fully redundant data centers that are powered entirely by renewable energy.

A Dell PowerEdge R720xd server with an Intel Xeon CPU E5-2630 processor running at 2.30 GHz was used to compare Sequor Systems with a pair of industry-leading web servers. Web server performance tests were run within VMware 5.5 hosted CentOS 7.0 Linux virtual machines that were configured with two and four virtual CPUs and four GB of RAM. Industry-standard open source web server performance benchmark utilities were used to emulate concurrent web server keep alive traffic with and without AES128 bit SSL encryption enabled.

The httpress utility was used to create a keep alive web server workload with a 100 byte payload, four threads, and 64 concurrent sessions. The weighthttp utility generated https (SSL) keep alive traffic with four threads and 256 concurrent sessions. Web servers were stopped and started between tests and no user processes were running except for the benchmark utility and a remote shell utility. The results are summarized in Figure 2 and Table 1.

**Figure 2. Unlocking Web Server Performance**



**Table 1. Web Server Performance Benchmark Results**

	2vCPU https (rps)	4vCPU https (rps)	2vCPU http (rps)	4vCPU http (rps)	4vCPU https vs. Sequor	4vCPU http vs. Sequor
Web Server A	10,341	20,287	17,060	34,361	3.83X	7.67X
Web Server B	19,941	39,921	52,210	102,478	1.95X	2.57X
Sequor Systems	40,880	77,654	135,513	263,547	-	-

Source: Enterprise Strategy Group, 2016

## What the Numbers Mean

- Web server requests per second is the key performance indicator that was used to quantify the performance gains that can be achieved with Sequor Systems non-blocking synchronization technology.
- Sequor Systems delivered up to 7.6 times more requests per second than web server A and 2.57 times more than web server B during http testing. During https (SSL) testing, Sequor Systems delivered up to 3.83 times more than web server A and 1.92 times more than web server B.
- Sequor Systems performance scaled in a nearly perfect linear fashion as the number of virtual CPUs was doubled.
- Sequor Systems delivered more performance with two virtual CPUs than either web server A and B with four virtual CPUs each (between 1.04 and 3.94 times more). In other words, Sequor Systems delivered more performance with half the number of virtual CPU cores.
- Sequor Systems SSL performance was more than double that of web server A and nearly the same as web server B without SSL. In other words, with the same hardware, Sequor Systems can deliver roughly the same performance with CPU-intensive 128 bit encryption as an industry-leading web server without encryption.

## Non-blocking Efficiency

Sequor Systems non-blocking synchronization technology delivers concurrent transactions quicker, which increases the utilization and efficiency of the underlying server hardware. Better efficiency can be used to increase the utilization, and density, of the physical server hardware deployed in private and public clouds. Increasing the utilization of industry-standard multi-core servers with Sequor Systems technology can lead to dramatic levels of ongoing operational expense reduction—especially for hyper-scale workloads running in cloud hosting and colocation facilities.

ESG Lab audited the results of a similar set of web server performance tests where energy usage was collected at one minute intervals with a smart power meter.<sup>5</sup> The energy that was consumed by the physical server was used to quantify the power and consumption benefits of Sequor Systems versus web server A and web server B.

The multi-core efficiency of the Sequor web server reduced energy consumption by 648% compared to web server A and 122% compared to web server B.



## Why This Matters

IT managers and hosting providers are struggling to cost-effectively meet the demands of the business—especially for business-critical concurrent applications with demanding service level agreements. Increasing the performance of concurrent applications running on industry-standard multi-core servers delivers bottom line benefits to the business.

ESG Lab has confirmed that patented lock-free synchronization technology from Sequor Systems can be used to dramatically improve the performance and efficiency of concurrent workloads. Performance gains of up to 7.57 times and energy savings of up to 648% were measured compared to industry-leading web servers. The Sequor Systems web server delivered more performance with SSL encryption enabled than industry leading web servers without encryption.

<sup>5</sup> [Data Center Performance and Efficiency Challenges: Disruptive Software Solutions](#), April 2016

## The Bigger Truth

ESG's annual IT spending intentions survey reveals that purchasing new technologies with a better return on investment and increasing the use of cloud computing services are the two most-cited measures that organizations are taking to reduce or otherwise contain IT expenditures in 2016.<sup>6</sup> Optimizing the performance and utilization of the hardware that's hosting concurrent workloads in a private or public cloud translates into lower data center costs (power, cooling, space) and a quicker return on investment. Increasing server performance and utilization delivers great bottom line value for concurrent workloads including legacy web servers, messaging services, and databases. Increasing the utilization of massively concurrent next-generation workloads, including big data analytics, Internet of Things, machine learning, and artificial intelligence, provides an even bigger bang for the buck and a quicker return on investment.

Hardware advances have provided the bulk of the server performance and efficiency gains in the data center over the past 40 years. Software is the new frontier that's fueling the next stage of growth. Server virtualization (e.g., VMware) and clustering technologies (e.g., Hadoop) are increasing application performance and utilization within and between servers. Concurrent programming is the next frontier. The concurrent programming software revolution began more than a decade ago in high performance computing and is entering the mainstream. Non-blocking synchronization is the latest wave of state of the art concurrent programming technology.

ESG Lab has confirmed that Sequor Systems non-blocking synchronization can be used to dramatically improve the performance and efficiency of concurrent application workloads running on industry-standard multi-core processors. Testing with an industry-standard web server workload confirmed a performance boost of up to 7.6 times compared to industry-leading web servers.

While the results that are presented in this report were achieved with the latest industry-standard multi-core processors, it should be noted that non-blocking synchronization can be used to deliver higher performance and efficiency on both legacy and single-core CPU packages as well. Sequor Systems indicates that the techniques that were used to achieve dramatic performance gains with relatively low density two and four virtual CPU core virtual machines have been shown to scale even more effectively on higher density CPU packages. As such, ESG believes that the results that are shown in this report provide a conservative estimate of the benefits of Sequor Systems technology.

If your developers are anxious to join the lock-free programming revolution with a goal of accelerating the efficiency of massively concurrent applications running on industry-standard multi-core servers, ESG Lab recommends that you take a close look at the Sequor Systems SDK. If your organization would benefit from a performance, efficiency, and bottom line enhancing turbo boost of up to 600% for its web server infrastructure, ESG Lab recommends that you seriously consider taking a Sequor Systems web server for a test drive.

<sup>6</sup> Source: ESG Research Report, [2016 IT Spending Intentions Survey](#), February 2016.

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