Improving Performance and Power of Multi-Core Processors with Wonderware and System Platform 3.0

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Introduction

Wonderware has spent a considerable effort to enable its Applications Server software component within the Wonderware System Platform 3.0 to take advantage of new breakthroughs in IT hardware and software technologies. As a result, most Wonderware Application Server users will be able to enhance the power of multi-core processors by implementing the Wonderware System Platform 3.0.

The proper distribution of loads between multiple application engines enables users to maximize the benefits of run-time hardware parallelism provided by multi-core CPUs. Users also will experience shorter development times due to the optimizations in configuration services. In addition, System Platform 3.0 software helps make it easier to develop and test applications incrementally due to faster and more robust configuration time operations such as application deployment, un-deployment, redeployment, check-in, check-out, configuration loading and export.

Evolution of Processor Technology

For the past four decades Moore's law, which states that the number of transistors that can be placed on a chip will double every 24 months, has held true. Until recently chip manufacturers kept up with this law by increasing the clock speed to achieve increased performance. However, increasing clock speed is not viable anymore due to heat dissipation and power consumption constraints. Instead of trying to increase the clock speed, chip manufacturers shifted to newer multi-core processor architectures. A multi-core processor is a single integrated circuit in which two or more processors have been attached for enhanced performance, reduced power consumption and more efficient simultaneous processing of multiple tasks.

The advent of multi-core (e.g. dual-core, quad-core and 8-core) processors presents both new opportunities and challenges. With increased hardware parallelism more work can be accomplished on a single processor. However, to take advantage of this hardware parallelism, software applications will need to be appropriately and adequately multithreaded. Unthreaded or improperly threaded software applications will perform poorly and become less competitive in the marketplace. For example, on a dual-core processor, an unthreaded or improperly threaded software program may utilize as little as 50 percent of the theoretical CPU available, whereas a multithreaded program could achieve up to two times improvement in performance.

The Wonderware Application Server componentized run-time architecture and its multithreaded configuration services make it “multi-core-ready.” The Application Server, built using "multi-core-ready” libraries, runs on the Windows operating system. Therefore, the Wonderware Application Server satisfies the “multi-core-readiness” requirements as defined by Intel, which requires the four layers of the software stack, including the operating system, device drivers, application libraries and development tools, to be multithreaded and “multi-core-ready.”

Wonderware Application Server 3.0 is “multi-core-ready”

Componentized Run-time Architecture Takes Advantage of Multi-Core Processors

The Wonderware Application Server run-time services are separated into several distinct processes and services (separate executables) such as aaBootstrap.exe, nmxsvc.exe, view.exe and aaEngine.exe, one for each Application Engine. Redundancy services provided by aabootstrap.exe and aaEngine.exe run on separate worker threads. Nmxsvc.exe, which provides off-platform communication services to application engines, also is multithreaded. If Wonderware InTouch HMI is used for visualization on a run-time node, it also runs as a separate process (view.exe).

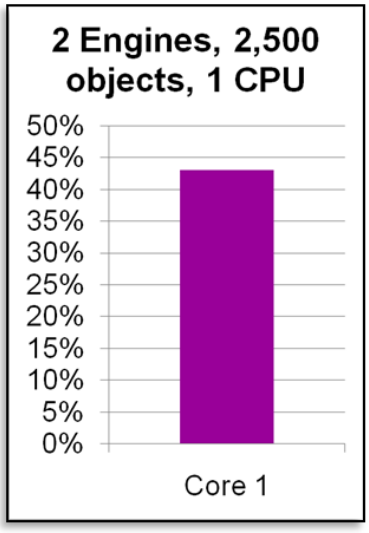
Optimal componentization and multithreading of essential run-time services has been achieved through careful application of standard computer science principles such as functional and data decomposition. On multi-core processors, at run-time, these distinct processes and threads could be running on separate cores as determined by the operating system. This provides better performance in terms of CPU utilization and added robustness to end-user applications.

The tests below compare CPU behavior and load on single-core (2.80 GHz Intel Pentium ® 4) and two dual-core (2.66 GHz Intel Xeon®) processors.

The first test was performed on the single core system using 2,500 objects that communicate with a PLC and perform calculations.

Single-Core application details test 1
1 Application Engine with 2,500 Objects, 2,048 I/O, 2 Active scripts on each object
1 Application Engine with ABCIP Objects with 2,500 Active advised I/O

The total average CPU load is 43 percent as shown in the chart below.

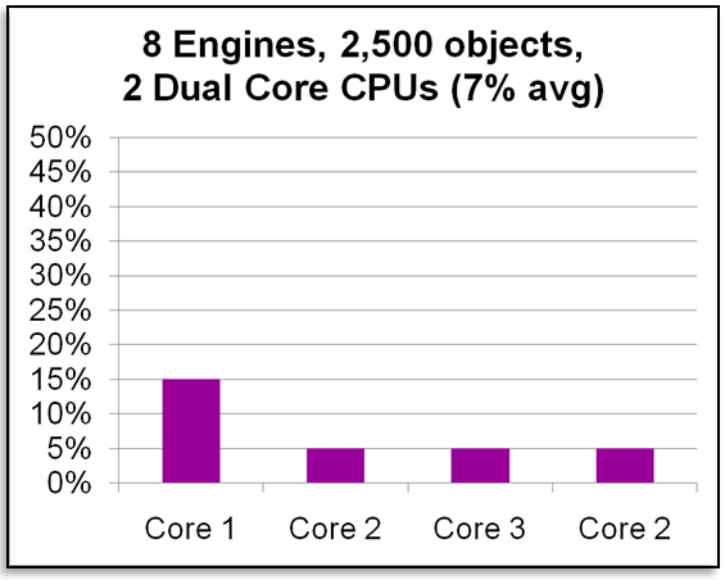


CPU load for single core test

The same application is then spread across four Wonderware Application Engines and run on a computer with two dual-core processors with the following specification:

Quad-Core application details test 1
4 Application Engines with 2,500 Objects, 2,048 I/O, 2 Active scripts on each object
4 Application Engines with ABCIP Objects with 2,500 Active advised I/O

The total average CPU load is 7 percent as shown in the chart below. The chart also shows that the load is distributed across all the processor cores.

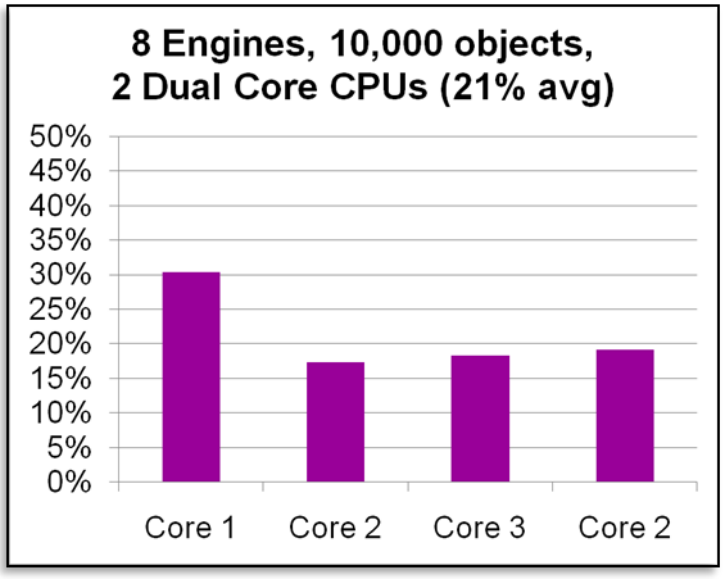


CPU load for multi-core test

Finally the application size was quadrupled and the same test was run on the computer with the two dual-core processors:

Quad-Core application details test 2
4 Application Engines with 10,000 Objects, 8,192 I/O, 2 active scripts on each object
4 Application Engines with ABCIP Objects with 10,000 active advised I/O

The total average CPU load is now 21 percent as shown in the chart below. The chart again shows that the load is distributed across all the processor cores.



CPU load with increased application size on multiple cores

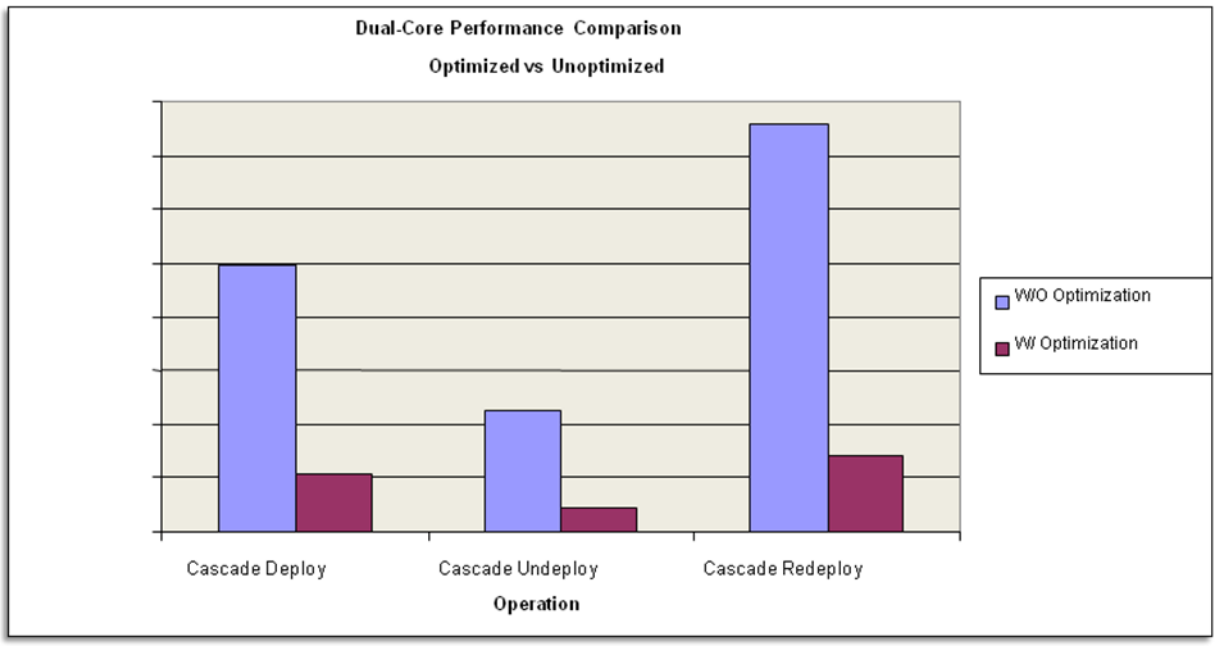
Although the application size on the quad-core system is four times than that running on the single-core system the screen shots in the figures above demonstrate that the Wonderware Application Server runs more efficiently on the two dual-core CPUs, consuming roughly half the CPU load.

Observations during the stress and functional testing have shown that on heavily loaded systems (i.e. running above the recommended/supported system loads) important operations such as failover caused by hardware or network failures and off-platform object-to-object communication were significantly faster on multi-core processors than on single-core processors. This observation can again be directly correlated to the componentized architecture and proper multithreading of the run-time services.

Configuration Services Optimized to Run Faster on Multi-Core Processors

The Wonderware Application Server provides a number of configuration services through the "aagr.exe" process. In general, these configuration services help users in developing applications and maintaining them. In version 3.0, a number of the more frequently used and computationally intensive operations are multithreaded to take advantage of hardware parallelism provided by multi-core processors. Without these optimizations, the same operations could perform much slower than on a single core processor.

Significant performance improvements can be observed in deploy and un-deploy operations when there are a large number of platforms and engines in this "Galaxy" (A Galaxy is an Application Server implementation). The chart below compares the performance of optimized (as in Application Server Version 3.0) and non-optimized deployment, non-deployment and redeployment operations on a dual-core processor. These performance benchmarks were collected using a test Galaxy with 40 platforms and 40 Application Engines.



The above chart clearly demonstrates how poorly an un-optimized (un-threaded or improperly threaded) software program could perform on a multi-core processor when compared to an optimized software program such as the Wonderware Application Server. The chart also shows the benefits of using multi-core computers in distributed applications, where each computer is able to perform optimally without waiting for the other computers.

Further, configuration operations heavily use Microsoft SQL Server 2005 which in turn is optimized for multi-core processors. Multi-user application development scenarios, which involve multiple users working on the same application, should also perform better. Overall, the Wonderware Application Server helps make developing and managing ArchestrA technology applications on multi-core CPUs faster and easier.

As the number of cores on a single chip is sure to increase in the not-so-distant future, these optimizations ensure the scalability of customer applications built with the Wonderware Application Server.

Future-proof your application with Wonderware Application Server 3.0

Application Servers Best Leverage Multi-Processors

In a distributed system it is not critical that the other system components, such as the visualization clients, leverage multi-core because these tend to typically be single process applications on dedicated PC platforms. The exception to this is in terminal services environments and Web servers where the Wonderware architecture does take advantage of the underlying optimization of Microsoft services within a multi-core architecture. This is because Wonderware InTouch HMI software runs as a separate process (view.exe) that can be dedicated to a separate core.

ArchestrA technology is applied in different ways to specific products. For example, device integration servers leverage the ability to separate the modeling of devices, networks and communications. Visualization components leverage faceplates and graphic symbol modeling and deployment. Wonderware Application Server components provide for a component-object-based environment that enables unlimited scalability, including distribution across multi-processor and multi-computer environments. Wonderware products truly behave as a single integrated system for real-time operations management solutions in any industry.

Additional Information

Intel's white-paper "Intel Multi-Core Processor Architecture Development Backgrounder"

http://cache-www.intel.com/cd/00/00/20/57/205707_205707.pdf

Intel® Multi-Core Processor Architecture Development:

http://softwarecommunity.intel.com/articles/eng/2285.htm

Multi-Core software:

http://softwarecommunity.intel.com/isn/home/multicore.aspx

Contact Wonderware or your local Wonderware Distributor for more information on industrial automation and information solutions.

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