Fast, Predictable, and Easy to Manage: Linux™ and Java™ Pave the Way to a New Real-Time Reality

Executive Summary

Computers may keep getting faster and more powerful, yet many organizations are still hampered by the inconsistent performance of their systems. While today's systems are capable of processing most transactions within a matter of milliseconds, there is still a percentage of these transactions that will take an order of magnitude longer to complete, because systems temporarily slow down from extraneous or internal housekeeping operations that may tax system resources.

For a growing number of organizations today, such unpredictability is disruptive, costly and unacceptable. A trading desk at a brokerage firm cannot ensure the integrity of its transactions if some are slowed because of a systems bottleneck. Financial services organizations are under pressure to assure that both front-office and middle-office transactions not only are executed at blazing speed, but also are consistently fast across the board - or else face the scrutiny of regulatory agencies.

That is why real-time processing with determinism - or the ability to deliver predictable, consistent results - is becoming a necessity. In the past, organizations have often had to commit large amounts of money and resources to achieve guaranteed response times and meet service level agreements. They either had to purchase and install specialized, real-time operating systems - a breed apart from general-purpose operating systems - or buy excessive amounts of hardware or memory. Plus, adding to the cost and complexity, special skills were needed to be able to install and maintain such systems.

Now, thanks to new developments in the market, real-time processing capabilities are available through standardized software solutions that don't require massive investments in skills or additional hardware. At the operating system level, Real-Time Linux is not only capable of delivering guaranteed sub-second response times, it is also based on the same kernel of the highly popular operating system used within organizations all over the world. This means that any site running Linux can seamlessly adopt the real-time version - with no additional special operating system skills required.

At the application level, WebSphere Real-Time offers a fast and deterministic version of the world's best-known development language. As is the case of Linux, Real-Time Java-based applications can be deployed with minimal impact on current configurations - with no need to re-learn a special-purpose language.

Real-Time Linux and WebSphere Real-Time offer a powerful combination that now makes it simple and affordable for organizations of all types to build out real-time operations with predictable performance.

Real-Time Means Predictability

Real-time processing means more than simply speeding up processing - it means the processing speed is more predictable when responding to events. To be competitive in today's markets, companies need to be able to process events and transactions within fractions of a second, but also be able to depend on the completion of the processing of events and transactions within a predictable period of time.

A typical strategy for achieving real-time processing with high availability and reliability has been to upgrade systems with more reliable hardware and software, add more memory, or build more redundancy into systems and components. While these are important strategies for many scenarios, they are often unnecessary, since processing slowdowns can occur from extraneous operations or internal housecleaning processes within the operating system or application software itself.

IBM now offers new solutions at both the operating system and application software level that provide real-time deterministic performance - and require little or no special hardware, software or skills to implement and operate.

Linux and Java - The Real-Time Power Duo

Real-Time Linux and Real-Time Java enable organizations to redirect critical resources to core business requirements, rather than expending time and money to supporting custom, low-latency systems.

Linux and Java offer a compelling combination for real-time, deterministic computing because they are widespread and easily accessible to end-users. Both types of software are developed and maintained by communities, rather than being tied into a single vendor. Both are platform-independent and based on industry-standard specifications, meaning they will run on just about any type of hardware on the market. Both provide enterprises with more flexibility and versatility than most other types of software.

Real-Time Linux

Linux, the powerful and versatile open source operating system, is well known for delivering impressive value to organizations, resulting from low to no upfront licensing costs, freedom from lock-in to expensive proprietary systems, and robust and highly scalable code.

While Linux adapts to many environments and hardware types, its real-time responsiveness previously did not stand out from other general-purpose operating systems. The open source operating system was not considered an option for companies seeking real-time processing environments.

This has all changed, however. Real-Time Linux, now available on the market from leading vendors, offers a real-time operating system engineered to reduce latency and increase the predictability and reliability of time-sensitive mission-critical applications. Such real-time capabilities are built into the same Linux kernel used for general-purpose computing. These real-time enhancements are being migrated into the mainstream Linux kernel. Thus, no special adaptations will be necessary to convert from standard processing mode to real-time mode.

Real-time operating systems such as Real-Time Linux prioritize processing requests, so that the highest-priority requests will always benefit from predictable response times. This helps shield system resources from extraneous operations that typically can overload or overwhelm a system. Real-Time Linux includes a number of new features, such as preemptive scheduling, which assigns priorities to processes. The Real-Time Linux kernel is offered with up to 99 priority inheritances, which ensure that high-priority applications are immediately assigned system resources.

In addition, little or no specialized skills are required to maintain Real-Time Linux above and beyond standard Linux development and administration capabilities. Organizations may leverage their current base of Linux or Unix expertise to manage a real-time operating system environment.

IBM supports an enhanced Linux kernel and supporting libraries based on Red Hat Enterprise Linux 5.1. IBM's Linux involvement is managed through the IBM Linux Technology Center. Real-Time Linux supports extended real-time POSIX application programming interfaces (APIs), and will run on select IBM System x machines, providing the best value in terms of hardware. The software also supports direct physical memory access, as required for Real-Time Specification for Java (RTSJ) conformance.

The real-time story doesn't stop with Linux at the operating system level. No computer is an island, and a typical process now crosses the boundaries of numerous systems. The ability to deliver real-time, deterministic computing is enhanced by the deployment of high-speed messaging middleware and application interfaces. That's where Real-Time Java plays a role in rounding out a real-time processing environment.

Real-Time Java

Organizations have increasingly been moving toward Java as a development environment due to the resource constraints of other languages such as C, C++, ADA, or COBOL. Developers find Java easy to work with, and the language is highly portable, and is supported by all the key operating systems and hardware platforms. Many skilled programmers are available for Java-based applications, and there is a massive community of independent software vendors built up

around Java. The object-oriented language has become the environment of choice for Web applications, middleware, tools, and service-oriented architecture (SOA).

Over the past decade, Java has become the language of choice for a range of enterprise and mission-critical applications. However, standard Java has inherently not been a deterministic language, and has problems in real-time environments - especially when handling large numbers of mission-critical transactions.

While most transactions in standard Java-language environments may occur within acceptable response times, unpredictable system events may delay processing. At any moment, internal housekeeping or garbage collection - the cleaning up of unused class objects from memory - may interrupt the execution of a process. Such pauses cannot be predicted ahead of time, and slow down the overall operations of Java applications.

These pauses can stop operations for over a second, which is costly in the trading world. Some analysts estimate that a latency of even a fraction of that can increase trade latency by a factor of 10, cutting into the profitability of trades.

A real-time operating system and software stack offers a degree of determinism not found in general-purpose systems. Real-time increases predictability, system availability, and reliability. WebSphere Real-Time garbage collection halts are greatly reduced in duration, from 500 microseconds to 1 millisecond - orders of magnitude shorter than traditional Java.

The Java platform now supports deterministic, distributed, real-time applications in mission-critical system applications ranging from weapons, command and control, industrial automation, financial systems to telecommunication infrastructures. WebSphere Real-Time enables organizations to take advantage of the flexibility of Java in a predictable processing environment. Improvements in Java performance are enabling organizations to use this versatile language for high-performance applications requiring sub-second response times.

By employing the RTSJ, the Java language has been extended to support real-time applications across embedded and enterprise environments. Programmers no longer have to rely on languages such as C, C++ or ADA 95 for real-time programming.

IBM's Real-Time J9 solution is designed to preserve the value of the Java language and platform through "garbage collection" as a central element. It reduces or eliminates the primary source of non-determinism via its one-of-a-kind "Metronome" garbage collection technology. This technology provides hard real-time determinism on the order of less than one millisecond.

IBM's Real-time Java software development kit (SDK) and Java Runtime Environment (JRE) are built using the major components of IBM Java technology, comprising real-time J9 Virtual Machine (JVM), a Java compliant virtual machine has been ported to 15 discrete operating systems and different hardware architectures from embedded processors (e.g., ARM), to Intel/AMD platforms, IBM pSeries, and IBM zSeries servers.

Real-Time Java delivers full support for Java Standard Edition (Java SE 5.0), as well as Java Community Process's Real-time Specification for Java. The software runs on SMP multiprocessor x86 Linux platforms (including BladeCenter). In addition, Real-Time Java includes a variety of compilers that can be used to optimize specific execution environments.

Through the use of existing J2SE, Version 5.0 class libraries, IBM WebSphere Real-Time retains the productivity and reusability aspects that make the Java development environment so attractive.

Real-Time Linux and Java in Action

Organizations rely on predictable, consistent processing speeds for a range of applications. Real-time software is already being deployed within leading organizations in key industry sectors that rely on real-time response times from their systems.

Managing Market Acceleration

Financial services firms have been buying the latest and greatest technology for years, in an effort to manage an explosion of data, support complex transactions, meet stringent regulatory requirements, and compete in fast-changing markets. Functions such as value-weighted average pricing (VWAP), derivatives pricing, and pre- and post-trade short-running analytic programs can benefit from real-time. In this industry, the ability to analyze and leverage the latest and freshest data means competitive advantage. To meet this challenge, firms are embracing high-performance trading and analytics systems.

At one financial services firm, the unpredictable performance of a real-time analytics application was hampering traders' ability to settle arbitrage in real-time. The firm needed to be able to provide real-time accounting of the value of its securities in order to resell at a profitable rate. The firm employs a real-time analytics engine to process current market data from multiple sources and make split-second decisions.

While most of its transactions were calculated and processed within an acceptable response time, its Java-based risk analytics application would occasionally slow due to garbage collection or another system housecleaning event. In these instances, traders and analysts were unable to assess current transaction values, and even a few seconds' delay could mean measurable losses. These system slowdowns resulted in missed trade opportunities that resulted in losses estimated at up to $200,000 a day.

The firm deployed Real-Time Java on servers running on Real-Time Linux, which eliminated the unpredictable system slowdowns, providing a consistent, uniform flow of data from the analysis system. The firm's traders were able to enact arbitrage trading with confidence knowing that they weren't acting on outdated pricing information.

IBM's Real-Time Leadership

IBM recognized that many mission-critical systems built on standard software have unpredictable performance, resulting in service level agreement failures, lost income opportunities, and even legal ramifications. There was a need for a new way to build real-time systems that are engineered for predictability and reliability, using the latest programming tools and techniques.

It is for this reason that IBM has taken the lead in investing in, developing and promoting cost-effective approaches to real-time determinism using standardized and open source software. IBM is working closely with leaders in the Linux community to support Real-Time Linux, carrying forward its commitment to the Linux community, which dates back to 1999. This commitment is evidenced by all IBM servers supporting the Linux operating system, more than 500 IBM software products on Linux, and a full line of implementation, support, and migration services for Linux.

IBM's commitment to the Java community extends back to 1995. IBM provides basic Java facilities on all IBM platforms as well as frameworks, components, and tools that make it easier to build robust Java applications. Real-time programming with an IBM WebSphere Real-Time technology-based solution provides IBM's best Java technology-based platform for addressing the sources of non-determinism while maintaining the benefits of the core Java development environment.

IBM continues its research and development effort to drive latencies in the IBM WebSphere Real-Time virtual machine down to the microsecond levels. IBM also continues to invest in growing the capabilities of the real-time platform as well as to increase the ease of use, making it simpler to develop, deploy and manage real-time solutions based on IBM's middleware products and tools.

Right Time for Real-Time

Enterprises leveraging real-time capabilities can respond more quickly than their competition to new information and changing market conditions. Running their time-sensitive mission-critical applications on Real-Time Linux, Java, and WebSphere middleware not only reduces process dispatch latencies, but also gives enterprises the time advantage

they need to reduce the risks of financial losses, and retain leadership in their markets.

To maintain this competitive edge, it is essential that high-priority transactions execute predictably at sub-second speeds. Real-Time Linux and Real-Time Java enables organizations to meet these requirements. Solutions are now available that enable organizations to move to guaranteed response time processing with little investment beyond current investments in Linux and Java programming.

While financial services organizations are seeing the initial benefits of Real-Time Linux and Java, there are numerous advantages for other industries, from government to healthcare to manufacturing. Real-time processing will provide predictability to applications such as real-time product simulations, language translation, and audio/video streaming, among others. For many industries, the time is now to move to real-time processing.

Contact your IBM representative today to learn more about how Real-Time Linux and Real-Time Java can benefit your organization.

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