



Case Study

Intel® Virtualization Technology

Industrial Automation

Platform Consolidation for General-Purpose and Real-Time Operating Systems

Announcing the End of the Two-Box Solution for Embedded, Real-Time Applications

Concrete production system harnesses TenAsys eVM* for Windows,* Intel® Virtualization Technology and high-performance, multi-core Intel® architecture to enable a single system to reliably and securely support both general-purpose and real-time operating systems.

Command Alkon

Solutions To Build On



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– Randy Willaman, senior manager of business expansion, Command Alkon

Case Summary

Situation: Command Alkon has millions of dollars invested in its proprietary software application: COMMANDbatch.* Thousands of concrete producers around the globe rely on it to manage, control, and facilitate the production of concrete – a highly perishable product. It is a real-time application developed to control a dedicated, custom-built hardware platform. Command Alkon customers have been using a standard desktop for the management side of the application, with a dedicated second “box” to perform the real-time functions. The two are linked by a network connection and are in constant communication with one another.

Challenge: With two complete sets of hardware needed, the two-box solution is expensive. Plus, the configuration introduces several extra points at which failure is possible, including the network connection between the two systems, the flash drive in the second processor, etc. Software support was difficult too, because the desktop application had to automatically download updates to the second processor for the real-time program. This function alone requires a great deal of custom, sophisticated, fault-tolerant software to be tested with every release. Command Alkon wanted a more efficient, reliable, and less costly solution, something that offers higher performance and is also easier to maintain. They considered porting the application to a programmable logic controller (PLC) or a new runtime environment, but determined such a move would be cost-prohibitive.

Solution: By deploying TenAsys eVM* for Windows* embedded virtualization platform software and an embedded multi-core Intel® architecture-based system enabled with Intel® Virtualization Technology,° Command Alkon can successfully run its legacy applications on newer, more reliable system hardware and eliminate the dedicated platforms needed for its real-time COMMANDbatch software. TenAsys eVM ensures determinism and absolute isolation of the real-time application and helps COMMANDbatch run better. “It’s crisper on the new platform,” says Randy Willaman, senior manager of business expansion at Command Alkon. “This solution extended the life of our software by another ten years – at least!”

The Just-in-Time Nature of Concrete

Unless you stop to think about it, it may not be obvious that concrete is a perishable product. After all, it's really hard stuff and it appears to be virtually indestructible. So much so that we use it everywhere: roads, bridges, tunnels, buildings, platforms, and more. You may wonder: what's so perishable about that?

Once mixed, concrete immediately starts curing – a chemical process that alters the initial goeey substance into the more solid condition we're familiar with. In fact, concrete never stops curing. And it has to be delivered to the pour site within a certain amount of time or it can't be used and has to be disposed of.

There are a number of infrastructure variables involved to make sure this happens in a timely manner: people have to be in the right place to spread the concrete, machines must pump it, and traffic has to be routed appropriately. "Once you start pouring, you need to finish the entire job. If something happens to interrupt this process, you have to create a seam to bind one batch to another," Willaman notes.

Complicating this process even further, plant managers and dispatchers have to balance competing demands of the particular job: how much is needed versus production capacity. A single job might require several different mixes at the same time. Walls, shafts, floors – all of them use different types of concrete, with different ingredients and formulas. There are also a number of supply chain issues that come into play including ensuring the availability of all ingredients when needed. All of which makes the concrete business a logistics business. Willaman sums it up this way: "It's all about reliability."

Command Alkon is in Control

Command Alkon delivers the infrastructure to support this entire production process and supply chain. Their software/hardware product known as COMMANDbatch is just one of the components of this complex infrastructure, but a key element in the logistics management and control of concrete production.

The real-time component of COMMANDbatch ensures the plant's ability to reliably produce the right type of concrete and deliver it at the optimum time. Simultaneously, while the plant is mixing concrete, dispatchers and plant operators use Windows-based tools to operate the business side of things, balancing the consumption of concrete with the plant's ability to produce it. In order for COMMANDbatch to manage things effectively, the real-time application and the Windows-based tools must be in constant communication with each other – reliably.

The Aging Two-Box Solution

Because embedded, real-time applications like COMMANDbatch are deterministic by nature and require access to specialized I/O devices and time-critical processing capabilities, manufacturers often use dedicated hardware to run them. Such is the case with Command Alkon.

The COMMANDbatch product currently installed at thousands of sites around the globe is a "two-box" solution, with some elements of the software running on each system and a network connection for communication between them. One of the boxes is a traditional desktop PC which runs the Windows operating system. The other box that Command Alkon affectionately calls "the brick" is a dedicated platform used to control the custom hardware system.

The brick provides dedicated, reliable, deterministic support for real-time production of concrete. By keeping everything separate from the Windows functions, the dedicated brick ensures low interrupt latency, direct access to specialized I/O devices, and a scheduling policy that respects the performance and deterministic requirements of a real-time application. Nothing else that's happening on the network can interfere with the logic processes that control the concrete plant and concrete production.

While reliable from a real-time control standpoint, the two-box solution isn't necessarily ideal. Maintenance and support must be provided for both systems, as well as the connection between them. And two complete sets of spare parts must be kept on hand at all times. This increases operating costs for both Command Alkon and its customers.

The two-box solution is also vulnerable in more ways than a single platform. For example, the connection between the two systems introduces extra potential failure points, such as twice the number of power supplies, not to mention extra connections between the systems.

"Millions of Dollars Invested"

Like many industrial automation companies, Command Alkon found itself caught between a successful product built for an aging platform and its customers' demand for change. Some might suggest the solution is easy: move to factory network solutions that run newer technology. But Command Alkon has its multi-million dollar investment in software code to consider – code that was written specifically to run simultaneously on both a Windows-based platform and a real-time operating system.

Porting its legacy application to non-Windows factory solutions (such as programmable logic controllers, or PLCs) would be cost-prohibitive. "We have millions of dollars invested in our code, and rewriting it for new hardware would be incredibly time consuming and expensive," explains Willaman. "Yes, our customers wanted higher performance and a more reliable, less costly platform. But a PLC wasn't the way to deliver it."

Considering Virtualization

After rejecting the PLC option, Command Alkon turned to the idea of deploying its solution on a virtualized system. The theory: by partitioning the hardware to run two different operating systems, Command Alkon could run both the real-time application and the Windows-based tools on one platform. An immediate benefit: legacy code would be able to run on a virtualized Windows-based system.

But as Command Alkon engineers began to investigate virtualization solutions generally, they discovered such platforms aren't all alike. For starters, determinism and native performance is vital for industrial applications because of the time-critical nature of system processing requirements. What's more, industrial applications require direct, native access to specialized I/O devices. In Command Alkon's case, this means access to control valves, scales, scanners, and other manufacturing devices through a dedicated I/O port. They use a serial port on the brick and would need a similarly dedicated connection on a virtualized platform.

Traditional software-based Windows virtualization applications – like those used in server farms to improve system utilization – aren't designed to support such determinism and performance quality. They are unaware of real-time priorities and latency issues and cannot distinguish the requirements of time-critical processing. Scheduling policies of these applications maximize hardware utilization, not necessarily performance-based tasks.

The Embedded Virtualization Solution

What Command Alkon needed was an embedded virtualization solution that supports time-critical processing and native performance of both Windows-based applications and real-time control – a solution delivered by the TenAsys eVM for Windows virtualization platform and hardware-based Intel Virtualization Technology.

The TenAsys eVM for Windows embedded virtualization platform is engineered for determinism and real-time dedicated performance qualities and has been validated to run on multithreaded Intel architecture enabled with Intel Virtualization Technology. The TenAsys eVM software ensures that one entire processor core on the Intel CPU is dedicated to the operation of a real-time application. The application itself sees that core as its own computing system and is not aware that is actually sharing any platform resources.

"Your time-critical software is signaled immediately by external events. Real-time applications execute deterministically, with the desired behavior needed to access I/O with all of the required native processing performance," explains Kim Hartman, vice president of sales and marketing at TenAsys. "Furthermore, the directed I/O capabilities of Intel chipsets ensure that eVM lets your real-time industrial application 'own' its I/O devices without any virtualization software interfering with functionality or performance." This means that any Windows applications running simultaneously can't interfere with the secure partitions created by the hardware and software virtualization solution.

The TenAsys eVM gives the COMMANDbatch solution an embedded virtualized platform that delivers:

- Native execution of both legacy and guest applications on a dedicated core – or processor thread
- Low interrupt latency
- Direct, native access to specialized I/O
- Scheduling policy that respects performance and determinism
- High-performance inter-processor communication

Intel® Virtualization Technology

Intel Virtualization Technology is a collection of hardware-based accelerators and security features that improve the fundamental flexibility and robustness of traditional software-based virtualization solutions. By accelerating key functions of the virtualized platform – on the CPU, chipset and network connections – Intel Virtualization Technology enables platforms to behave as if they were separate systems, yet share resources for optimum efficiency. Implemented in the processor, chipset, BIOS and network connection, Intel Virtualization Technology creates a complete and isolated virtualized platform that:

- Speeds up the transfer of platform control between the guest OSs and the VMM by using hardware assist to trap and execute certain instructions on behalf of the guest OSs;
- Enables the VMM to securely assign specific I/O devices to specific guest OSs, where each device is given a dedicated area in system memory accessible only by the device and the designated guest OS, removing the VMM from every I/O transaction; and,
- Optimizes the network for virtualization with adapter-based acceleration by performing device queuing and PCI-SIG Single Root I/O Virtualization (SR-IOV) functions.
- Intel Virtualization Technology is available on many of Intel's newest processors, chipsets and I/O devices.
- The TenAsys eVM* for Windows* virtualization platform has been validated on multi-threaded and multi-core Intel® architecture processors and chipsets. As a member of the Intel® Embedded Alliance, TenAsys gets early access to the embedded Intel roadmap so that hardware-based virtualization can be tested and supported by the TenAsys eVM when silicon becomes available to customers.

No More Two-Box Solution!

"That's probably the biggest benefit of choosing a virtualized solution based on the TenAsys eVM for Windows software platform and Intel Virtualization Technology," says Willaman. "And it's huge, because we save on support and maintenance costs and only have one set of parts to keep on hand."

Command Alkon customers will also enjoy the easier deployment of the consolidated solution. For example: "It's subtle, but important, because we can now bundle the installation as part of our process using TenAsys tools, so it's seamless for us and our customers."

Speed is also a factor. "The additional processing power available from the multi-core Intel platform provides better overall performance for our software," Willaman adds. "It runs better on this platform. It's crisper, sharper, and reliable."

The availability of Intel Virtualization Technology for directed I/O is another benefit. "It really helps to have access to virtualized and dedicated I/O for a separate NIC, giving us real-time control out over

the network," he adds. "It completes the real-time control function and allows us to partition the entire hardware platform in such a way that the real-time system can depend on being serviced by the platform in deterministic fashion. That's key."

For Command Alkon, the move to a virtualized platform solution is likely to extend "the life of our software by another ten years – at least!" says Willaman. "What our customers value most about our product is our proprietary software. As long as it runs reliably, is cost-effective and easy to maintain, they're happy. This solution gives them everything they need and makes our business that much more effective."

Followed by the End of Custom Hardware?

While Command Alkon is currently focused on eliminating the brick, the next step will be to move from proprietary hardware to more general-purpose factory automation hardware for the control of concrete production.

"The exciting thing about TenAsys eVM for Windows is that we can continue to use our real-time software and use the factory automation hardware as I/O, without having to write much code for the processor(s) in the new I/O hardware," Willaman explains. "When this happens, we may need to ask TenAsys to add additional hardware drivers to talk with fieldbus-type I/O cards that we'll put into the desktop processor, but I have confidence in the eVM architecture and the company's engineers, and I know they'll be able to get it done for us."

For Willaman, the benefit is obvious: "This further extends the life and reach of our legacy software application, which is the real IP value of our solution."

Plan for Deployment

Many embedded and industrial customers are familiar only with server software-based virtualization applications and may be skeptical about the benefits of hardware-based, embedded virtualization solutions. The TenAsys eVM virtualization platform and Intel Virtualization Technology are more advanced solutions that warrant another look. When put together, embedded Intel architecture, hardware-based

About Command Alkon

Command Alkon is one of the world's largest suppliers of batching, dispatching, quality control, fleet management, GPS, and electronic document management products for construction materials producers.

About TenAsys

A leading, real-time virtualization expert, TenAsys Corporation, specializes in operating software for the embedded computer industry, designed and optimized for the Intel® x86 platforms using the Microsoft Windows® OS and the Visual Studio® development environment.

Virtualization Technology, advanced multi-core Intel processing, and embedded-specific VMM solutions have the potential to remake the business of industrial automation so that it's more efficient, reliable, and costs less to maintain.

Proof that embedded virtualization is viable: Command Alkon has thoroughly vetted the solution and is convinced of its reliability and performance. Plans are in place to offer new customers to the virtualized, one-box version of COMMANDbatch, including the TenAsys eVM for Windows virtualization platform and a dual-core Intel architecture-based computing system. Existing customers will be offered the opportunity to upgrade when their annual maintenance contracts come due for renewal.

For More Information

www.intel.com/technology/advanced_comm/virtualization.htm

www.commandalkon.com

www.tenasys.com/products/evm.php



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