Case Study

"By working with TenAsys®, we will automatically be able to take advantage of processor hardware developments from Intel as well as Microsoft*'s OS evolution."*

INtime® Software Lets Biesse Group* Combine Real-Time Processing with Microsoft* Windows* Applications

How workload consolidation improves system functionality and reliability.

When the team at woodworking machinery manufacturer Biesse Group* considered how to update their CNC system, they looked for a real-time operating system (RTOS) that would meet the timing requirements of their application without requiring additional effort in operating system development or compromising the performance of Biesse's Windows* application software. They selected INtime® for Windows.

tenAsys®

Overview

Computer numerical control (CNC) machines are some of the most complex systems in the manufacturing world. Even the simplest CNC machines may have four motors driving motion axes that must all move synchronously, at high speed, with very high precision to maximize the machine's productivity and quality of output. The motion controllers that orchestrate them must make decisions on how to move motion axes and establish new target positions every one or two milliseconds.

Challenge

Biesse Group* is one of the world's foremost providers of machinery for wood, glass, and stone processing and fabrication. One of Biesse's North American customers is Simard Cuisine et Salle de Bains, a manufacturer of kitchen and bathroom cabinetry in Quebec City.

Simard now uses Biesse Group's Rover Gantry 512 CNC router, but that wasn't always the case (Figure 1). Recently, the cabinet manufacturer needed to upgrade a panel saw and machining center with a modern platform that delivered the same control functionality alongside a new user interface and enterprise features like data logging, support for machine program development, and interfaces to IT networks (Figure 2).

Figure 1. The Biesse Group's Rover Gantry 512 installed at Simard Cuisine et Salle de Bains in Quebec City, Canada.*

Figure 2. The Biesse Group Rover Gantry machine's HMI runs on Microsoft* Windows*.*

The new features meant a full-featured OS such as Windows* was required, but Simard could not compromise on real-time performance.

"The loss of a single control cycle is a mission-critical failure," said Paolo Menghi, Technology Manager, R&D at Biesse Group of Pesaro, Italy. "If one of our machines failed to update its target positions correctly for just a millisecond or two, inaccurate cuts could be made, and the machine could jam or become unstable."

To guarantee the machine's outputs are produced on time the machine's inputs need to be sampled much faster – typically many times faster than output decisions need to be made. Control engineers call the phenomenon of missed control loop times "jitter" because if one were to look at a graph of the motion produced by imprecise control loops, it would have jagged lines or small discontinuities. The results can be machine maintenance problems and poor-quality outputs.

But even a one- or two-millisecond response time is not the fastest response that the system must make. Because of high-precision timing and oversampling requirements of some fieldbus (machine network) interfaces (e.g. EtherCAT*), the cycle times of control loops that manage these need to be as short as 100 microseconds. A human-directed operating system such as

Microsoft* Windows cannot manage all these control tasks simultaneously and guarantee that they will be processed with predictable timing (i.e., determinism), so most high-speed machines run their control loop software on an RTOS.

So, the challenge for CNC machine developers is to combine both real-time and human-directed operating environments in the same system. Historically this has been accomplished by using two separate computers in the machine: one running the RTOS and one running Windows.

Solution

A better solution is to host all the real-time and non-real-time applications on a single processor. The key to combining these environments is embedded virtualization, the ability for the system to support a heterogeneous mix of operating environments, both real-time and human-directed, simultaneously.

After doing research on different real-time operating environments, Biesse engineers identified the INtime® for Windows from TenAsys® Corp. as the best solution for adding real-time functionality to a platform running Windows. Other "real-time Windows" products require modifications to be made to the Windows operating environment or special drivers to be used with Windows in order to sidestep Windows' non-deterministic task scheduling. "INtime works with all standard Windows versions right out of the box," said Giuseppe Guerrini.

To run alongside Windows natively without additional components like a hypervisor, INtime employs explicit partitioning. Explicit partitioning is a unique product of INtime's built-in embedded virtualization capability that allows the RTOS to be configured such that INtime and Windows instances can occupy separate processor cores, memory spaces, and I/O on the same host (Figure 3).

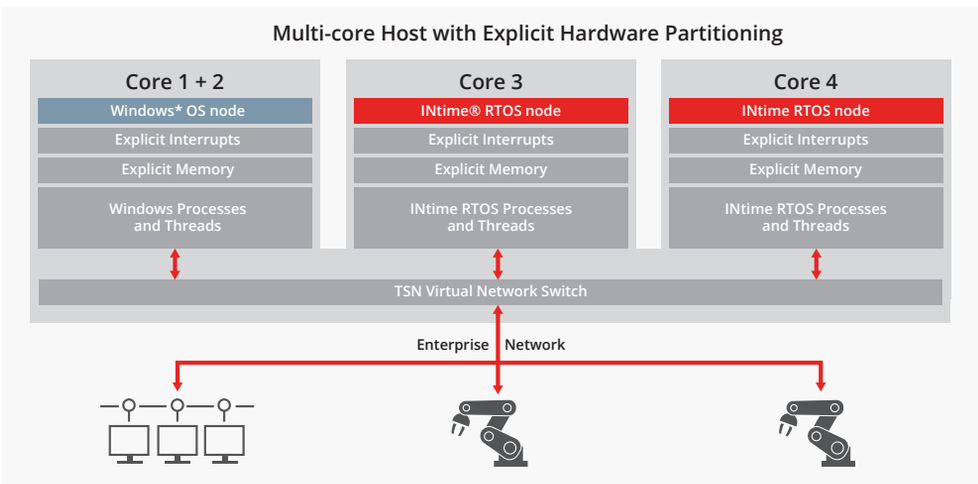

Figure 3. Depicted here is an example of embedded virtualization at work in an explicitly partitioned system that dedicates two cores each with their own processor core, memory, and I/O resources to time-critical control tasks and an additional two cores to non-time-critical network, database, and user interface functions.

INtime communicates with Windows using the TenAsys NTX dynamic link library (DLL). This inter-process communication (IPC) mechanism can interface with multiple instances of INtime and allows the RTOS to maintain strict deterministic control of real-time processes, leaving non-time-critical tasks to the Windows environment.

In Biesse's Rover Gantry 512 machine, motion control cycles, I/O drivers, supervisory PLC logic, and fieldbus drivers (EtherCAT, CANopen) are executed as real-time processes by TenAsys' INtime software, while the machine's HMI functions—including CAD/CAM system, and many third-party applications that its customers typically install—run as Windows processes and communicate with the real-time software using functions from INtime for Windows' NTX DLL (Figure mech).

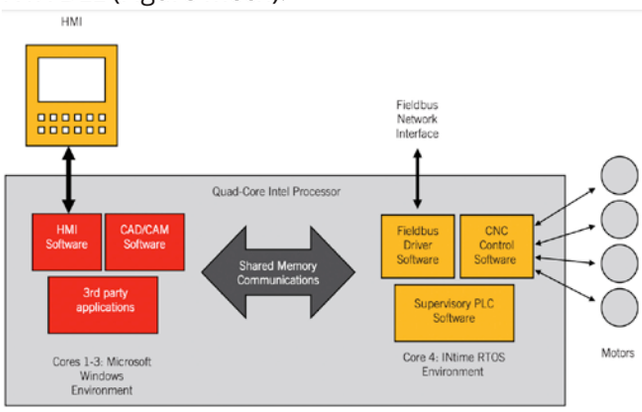

Figure 4. The quad-core Intel Core* i5 processor in the Biesse Group* computer runs Windows* on three cores and the Intime® RTOS on the other core.*

Again, all these workloads can be consolidated on a single hardware platform.

Results

At the most basic level, workload consolidation that combines machine control and HMI functions on the same system has improved the reliability of hardware. "As we now have about 50% of the hardware of a two-platform control system, our MTBF has doubled and our service department saves costs by managing fewer spare parts." said Francesco Tabanelli, Biesse's Motion Control Chief Engineer. In addition, by using standard commercial desktop PCs, Biesse can change the model used about every year. "This always gives us the best price/performance ratio," said Tabanelli. "Currently, we use only one processor core for real-time tasks, but we can add INtime kernels on other cores, so we can tune our system depending on machine complexity."

Today, Simard Cuisine et Salle de Bains uses Biesse's Rover Gantry 512 to perform all precision drilling, boring, milling, and cutting operations on a single panel in less time than was possible with Simard's previous machinery while giving Simard more flexibility in the design of the company's cabinets than was previously possible.

Besides solving performance and determinism problems, another important factor for Biesse is the need to keep pace with evolving application requirements for the company's CNC products. "By working with TenAsys, we will automatically be able to take advantage of processor hardware developments from Intel as well as Microsoft's OS evolution," said Menghi.

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