

Solution Brief
Intel® Product Technologies
Industrial Industry

Computing Technologies for the Industrial Pyramid

Advanced Intel® Product Technologies Reduce System Cost and TCO

Manufacturers, facing intense global competition, are increasing productivity and cutting costs by linking systems throughout the organization, from factory-floor management to global sales organizations. As a result, production managers can monitor operator and materials efficiency in real-time, as opposed to waiting until the close of the production day for key operational information. Similarly, there is greater efficiency in customer and supply chain management when data is readily available across the industrial pyramid, comprising soft PLCs, CNCs, factory workstations and corporate servers.

Further cost reductions can be realized when equipment in the industrial pyramid is designed with the latest computing technologies that reduce system cost and total cost of ownership (TCO). Helping industrial original equipment manufacturers (OEMs) achieve these objectives, Intel® processors, chipsets and product technologies are delivering many capabilities to provide key benefits, such as:

- **Cutting equipment support costs** by improving remote diagnostic and repair capabilities
- **Reducing system costs** by consolidating software onto a single board
- **Lowering utility costs** by saving power whenever the software workload decreases

This solution brief discusses how Intel® vPro™ technology and Intel® Power Management Technologies, which are built into select Intel silicon components, improve remote management, virtualization and power utilization capabilities, thereby enabling industrial OEMs to deliver more cost-effective equipment and create a competitive advantage. Equipment with Intel vPro technology enables manufacturers to take advantage of hardware-assisted security and manageability capabilities that enhance their ability to maintain, manage and protect their factory-floor and top-floor infrastructure.

Keeping Systems Online with Remote Management

When a piece of factory equipment goes down, an on-site technician may be required to fix the problem and get the production back online. It can take hours, even days, to get a technician out to the plant to fix the defective systems, resulting in lost revenue. Alternatively, manufacturers and industrial OEMs are turning to remote management solutions to diagnose, repair and get equipment online faster and at a lower cost.

Today, most industrial automation equipment is connected to a data network, which carries production flow and manufacturing data. The data network can also provide the communications link for remote management terminals used for many IT support tasks, such as updating software, repairing systems and collecting inventory information. When communicating with remote management systems, many manufacturing automation systems use the same networking functionality (e.g., Ethernet NICs, CPU, operating system, protocol stacks) for both standard LAN and remote management communications. When equipment fails, this “in-band” approach has the drawback of relying on the continued operation of many equipment components: CPU, operating system, hard disk drive and system memory. In other words, if the system is not functioning, the only option may be to send a technician.

Providing a significant remote management breakthrough, Intel vPro technology with Intel® Active Management Technology (Intel® AMT) implements a special circuit in the Intel® chipset that can access and control the system, even if it is powered off or the software is corrupted. This circuit establishes an “out-of-band” link that allows the system to communicate with a management console without relying on the system’s standard networking functionality. By employing Intel AMT-based management solutions, manufacturing IT departments can remotely fix a wide assortment of system defects, track intermittent failures and run inventory reports, including warranty and software license information, as described in Table 1. This capability reduces cost and saves time by supporting devices without requiring hands-on intervention. Intel® Core™2 Duo processors combined with Intel AMT can support a wide variety of devices, including human-machine interfaces (HMIs), soft programmable logic controllers (PLCs) and corporate servers, as shown in Figure 1.

Reduce Onsite Repair Costs

When automation equipment, workstations or servers won’t boot due to corrupted software (e.g., OS, driver or critical application), the usual remedy is to send a technician on-site to reload the software image. Using Intel AMT, it’s possible to remotely boot a device from a networked drive (golden disk in Figure 1) with known-good software, which greatly aids in troubleshooting. IT can also remotely change BIOS configuration settings, load new drivers or load a new operating system, whether or not the system is running.

Capabilities	Results
Fix Hung Systems	Restore systems by cycling power, reloading software or booting from a ‘gold’ hard drive on the network.
Track Intermittent Failure Modes	Access error log and event records from FLASH, accessible at all times to the remote console.
Run Inventory Reports	Remotely read system configuration data from non-volatile memory, even if the system is switched off.

Table 1. Intel® Active Management Technology Capabilities and Results

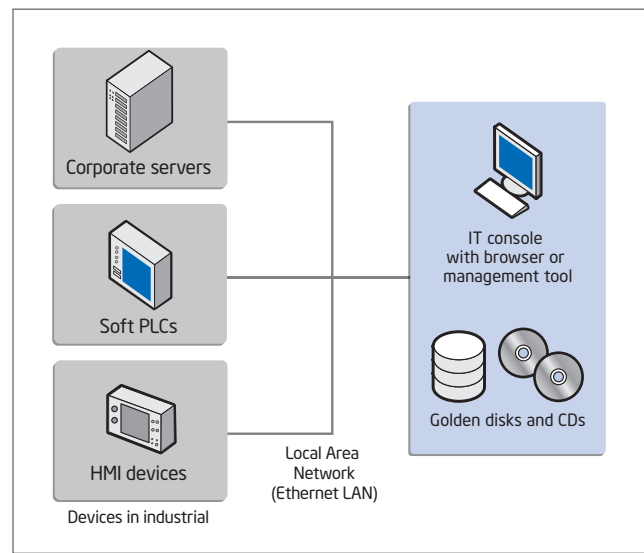


Figure 1. Remote Management Solution for the Industrial Pyramid

Track Intermittent Failure Modes

When logging events and errors, factory and top floor systems are leaving valuable clues about their health, including intermittent fail conditions that could eventually turn into a hard failure. With Intel AMT, systems continually store this information in non-volatile memory, accessible at all times to the remote management system, regardless of the system state. If an on-site visit is required, this capability can help identify failed components in advance, which enables technicians to arrive with the appropriate spares and repair systems faster.

Track Inventory without Physical Interaction

Many manufacturers resort to physical methods to perform a fixed asset inventory, especially to track equipment that’s turned-off, non-functioning or dispersed across multiple manufacturing sites. Eliminating human intervention, Intel AMT enables management systems to generate a comprehensive list of hardware and software components for any device that’s plugged into the network and an electric socket. This capability also enables IT departments to monitor the software, by version, warranty and license, of every device on the network.

Reducing System Cost with Virtualization

Running millions of lines of code, industrial control systems provide the intelligence for the factory floor. Manufacturing IT must ensure there are no software conflicts, even though the code comes from various sources, like industrial OEMs, in-house programmers, legacy systems and third-party vendors. For example, there's a trend to consolidate motion control, PLC and HMI functionality all onto a single board, which reduces hardware cost, overall power consumption and device size.

Today, most embedded industrial systems run a single OS, typically real-time, general-purpose or homegrown. If developers want to add a legacy application running on a different OS (e.g., DOS), they probably have to rewrite the software, which can be time-consuming and risky. Alternatively, developers can choose to run multiple OSs and their associated applications in secure partitions using virtualization. Virtualization has been around for many years, most notably used in data centers where many applications are consolidated onto a single server. Complementing software-based virtualization solutions, Intel® Virtualization Technology² (Intel® VT) improves their performance and robustness and gives software developers greater control over operating systems and applications. This capability facilitates software consolidation, increases real-time performance and safeguards safety-critical code, as shown in Table 2 and described in the next three sections.

Consolidate Software

Some industrial control systems require two boards to implement both human-machine interface (HMI) and PLC applications because they run on different OSs. Virtualization enables a single board to run multiple OSs and their associated applications, as shown in Figure 2, which saves hardware cost compared to a multi-board solution. Easing software migration for system developers, virtualization enables a legacy application, like a protocol stack supporting a legacy I/O device, to run unmodified on its native OS.

Increase Real-Time Performance

It's not enough to reach the correct result; many industrial controllers require a combination of low latency, deterministic response and full-featured user interfaces. Satisfying both objectives, virtualization and multi-core processors enable systems to simultaneously run real-time and general-purpose OSs, each on its own dedicated processor core. This configuration can increase the speed and determinism of time-critical applications, because they operate unencumbered by non-real-time tasks that would otherwise compete for CPU resources.

Capabilities

Benefits

Capabilities	Benefits
Support multiple applications on a single board	Eliminates boards, saves power and reduces device size
Run an RTOS on a dedicated processor core	Improves real-time performance
Secure safety-critical code	Reduces certification effort

Table 2. Intel® Virtualization Technology Capabilities and Benefits

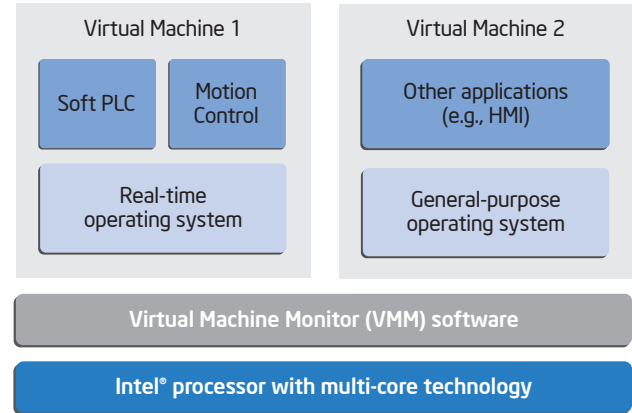


Figure 2. Virtualization Isolates Real-Time Code

Improve Security with Application Isolation

A major challenge facing device manufacturers is that during the certification process, they must meet the requirements specified for safety-critical software and demonstrate that it's separated or protected from other parts of the system. When applications run in a secure partition, labeled virtual machine in Figure 2, their memory space is protected by hardware features in Intel processors and Intel VT. This means software components running in virtual machines only have access to their own code and data regions, which increases security by preventing applications from interfering with or breaching one another.

Balancing Performance and Power Consumption

Industrial OEMs understand the profound impact power consumption has on device size, end-user utility bills and attainable performance. A very effective way to manage power consumption is to put the system into a lower power state when the system workload decreases. Intel processors support a number of power states that enable substantial power savings and design flexibility, and are accessible through the industry-standard Advanced Configuration and Power Interface (ACPI). For example, the power states of the Intel® Core™2 Duo processor SU9300 establish a wide range of power consumption levels, from 10 W to 0.25 W TDP (thermal design power), as shown in Figure 3 on the next page.

In conjunction with power states, the Intel technologies listed in Table 3 enable systems to strike the right balance between computing performance needs and power consumption. They give software developers granular control over the system operation with respect to performance and power. Industrial OEMs may also use Enhanced Intel SpeedStep® technology to put a ceiling on the system power consumption in order to reuse a board design in more thermally constrained environments. For example, OEMs can limit the maximum power consumption of a high-performance industrial controller when they want to reuse the same board in low-end applications. Software engineers can easily prohibit systems from entering high-performance states and satisfy more stringent maximum power consumption requirements. Power management technologies address many design challenges, like conserving power and creating a scalable platform, as described in the following sections.

Reduce Average Power Consumption

Manufacturers take overall power consumption seriously because they must pay for electricity to power their equipment and then again to remove the generated heat from the plant. Application software can intelligently cut power consumption by moving to a lower power state or invoking Intel SpeedStep technology and dynamic FSB frequency switching when equipment is operating below maximum load. When systems can be shut down during non-use times, such as evening or weekends, Intel AMT can be used to remotely turn devices on and off, further saving power.

For example, it's possible to significantly reduce overall power consumption in an HMI device by automatically changing to a lower power state between key presses. It should be noted that if a processor is switched to a lower performance operating mode to benefit from lower power consumption, its real-time response will be impacted. Additionally, switching between power states and Enhanced Intel SpeedStep technology operating points produces a delay, which will have a momentary impact on the processor's deterministic performance.

Support Many Devices with One Platform

Although industrial automation systems come in all shapes and sizes, many implement similar computing and I/O subsystems, which can be supported with a scalable platform. Such a platform must have high-performance options for top-end systems and low-power alternatives for space-constrained environments. Intel® platforms with Enhanced Intel SpeedStep technology satisfy both because designers can run the processor full-board in performance systems or lock in a processor frequency and voltage combination that meets strict power requirements. Industrial OEMs can create a family of products with different performance and power consumption objectives using a single platform based on Intel's silicon products.

Power Management Technologies

Capabilities

Processor States (C-states)	C-states manage power consumption at the processor core level.
Enhanced Intel SpeedStep® Technology	Allows applications and operating systems software to change the processor supply voltage and frequency, enabling optimal performance at the lowest power.
Intel® Dynamic Front Side Bus Frequency Switching	Halves the processor front side bus (FSB) frequency, as directed by application software, providing further power savings.

Table 3. Power Management Technologies and Capabilities

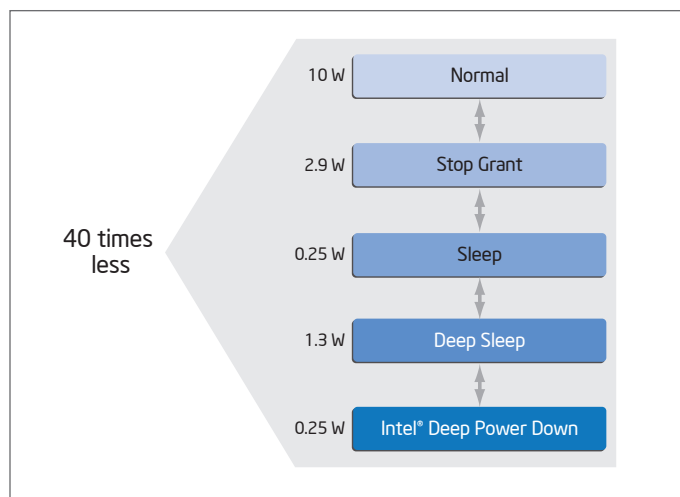


Figure 3. Power State Example

Reducing Manufacturing Costs

Seeking a competitive advantage, manufacturers are deploying the latest computing and networking technologies to increase operational productivity and product margins. They can also benefit from additional cost savings when industrial OEMs employ Intel product technologies that can eliminate hardware, improve system support and cut power consumption. These Intel® solutions for remote management, virtualization and power management can be applied across the entire industrial pyramid, including soft PLCs, motion controllers, HMI devices and corporate servers.

For More Information

For more information on Intel® product technologies, visit www.intel.com/technology/advanced_comm.

Additional information about Intel® embedded products can be found at www.intel.com/products/embedded/index.htm.

¹ Intel® Active Management Technology (Intel® AMT) requires the computer system to have an Intel AMT-enabled chipset, network hardware and software, as well as connection with a power source and a corporate network connection. Setup requires configuration by the purchaser and may require scripting with the management console or further integration into existing security frameworks to enable certain functionality. It may also require modifications of implementation of new business processes. With regard to notebooks, Intel AMT may not be available or certain capabilities may be limited over a host OS-based VPN or when connecting wirelessly, on battery power, sleeping, hibernating or powered off. For more information, see www.intel.com/technology/platform-technology/intel-amt/.

² Intel® Virtualization Technology requires a computer system with an enabled Intel® processor, BIOS, virtual machine monitor (VMM) and, for some uses, certain platform software enabled for it. Functionality, performance or other benefits will vary depending on hardware and software configurations and may require a BIOS update. Software applications may not be compatible with all operating systems. Please check with your application vendor.

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