Case Study
BECKHOFF

Collaboration Accelerates the Internet of Things and Industry 4.0

Driving Innovation in the Factory by Consolidating Systems with PC-Based Control Technology

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The number of connected devices that can share data is growing exponentially, with estimates of up to 75 billion devices being connected to the Internet by 2020.[1] Commonly referred to as the Internet of Things (IoT), this rapid proliferation of connected devices represents a transformative change for the industrial sector, most notably through the convergence of information technology (IT) and operation technology (OT).

The dramatic growth in connections, including those among new devices and legacy infrastructures, has also triggered an unprecedented spike in data volumes. That data represents untapped production efficiencies, competitive business insights, and new, brand-differentiating services—but only if the data can be effectively analyzed and its value realized.

As companies seek to adapt and capitalize, they must address a range of challenges, including a marketplace that has grown increasingly global, fast-changing application requirements, and ever-greater demands for improved profitability. Progressive companies are responding by looking to improve their processes through the “big data” related to their production status, equipment condition, and other vital facets of operation.

Harnessing IoT and Industry 4.0 for Smart Factories

To fully realize the promise of IoT, disparate systems need to securely connect, interoperate, and communicate. A key step in helping industrial companies capitalize on IoT, and a related technology concept called Industry 4.0 specifically addressing the industrial or factory environment, involves establishing better horizontal (i.e., shop floor), machine-to-machine communications. Such a move addresses an issue often identified as “islands of automation” in which machines and/or machine modules do not fully communicate with one another.

What Is Industry 4.0?

Industry 4.0 is a high-tech strategy that promotes the computerization of the manufacturing industry. The goal is the intelligent or smart factory, which is characterized by adaptability, resource efficiency, and ergonomics as well as the integration of customers and business partners in business and value processes.

The technological strategy is based on cyber-physical systems and the Internet of Things.[2] Industry 4.0 has its roots in Germany but is spreading worldwide to other industrialized nations, including the U.S.

Also critical is vertical communication to enterprise resource planning (ERP) and manufacturing execution systems (MES) ("shop floor to top floor" or "sensor to cloud"). In this phase, data from the machinery or process can be used for the following:

- Overall equipment effectiveness (OEE)
- Track and trace systems (traceability)
- Modern energy management
- Condition monitoring of high-value capital equipment
- Reducing work in progress (WIP)

The hurdle is obtaining the data easily and via standard interfaces as traditional machine control technologies were not designed for built-in direct connectivity to ERP and MES. This has driven IT organizations to become more involved in helping make the necessary connections. As a result, the cooperation and collaboration among IT and controls engineers are of crucial importance today.

Another important consideration is that Industry 4.0 requires a high degree of networking and communication between devices and services. Large data quantities must be exchanged, from the sensor to the datacenter and back. The corresponding protocols and standards offered by PC-based control make it an ideal solution for these tasks. This applies to the makeup of the hardware (e.g., Intel® processors), the standard connectivity technologies (e.g., Ethernet, USB, serial), and the software (e.g., Windows*-based operating systems, additional standard tools/software solutions from Microsoft and other global IT companies).

Intel and Beckhoff are helping companies implement Industry 4.0 concepts through innovative solutions that help connect, secure, manage, and analyze devices and data. A technology leader for nearly half a century, Intel is accelerating Industry 4.0 and IoT through high-performance, scalable architectures that provide the backbone of embedded industrial automation, software portability from the edge to the datacenter, and comprehensive hardware/software security, equipping its partners to adapt and innovate. Beckhoff has been designing industrial automation solutions for more than 34 years and brings industry-leading expertise in integrating controls, including both horizontal and vertical communications throughout the factory.

The Convergence of IT, OT, and AT

From the company's earliest days, Beckhoff Automation has driven the convergence of IT, OT, and automation technologies (AT) for higher performing, more streamlined, and better connected automation systems. A major software component to this is Beckhoff's TwinCAT* (The Windows Control and Automation Technology*) software platform. With this PC-based programming environment and runtime software, most open PC-based hardware can be used as an automation device. The vast majority of Beckhoff PC-based controllers—industrial PCs (IPCs), embedded PCs, and panel PCs—rely on advanced Intel processor technology, including Intel® Core™ processors.

The newest version of TwinCAT software, TwinCAT 3, further takes advantage of standard IT technologies to enable more options for computer science-style programming in automation (Visual Studio*, C languages, .NET, Java*, etc.) and integration of lab software packages such as MATLAB*/Simulink*. TwinCAT 3 also enables "core isolation" or "core-splitting" so that Intel® multicore processors can dedicate certain cores to specific automation and controls tasks. For example:

Core 0 — The human machine interface (HMI) software

Core 1 — Multiple programmable logic controller (PLC) tasks

Core 2 — The motion control system

Core 3 — Advanced measurement and condition monitoring tasks

Intel supports the convergence of IT, OT, and AT with a scalable roadmap of the world's most reliable silicon, improving flexibility and efficiency by enabling a predictive and adaptive factory. From Intel® Atom™ processors embedded in edge devices and gateways through Intel® Xeon® processors in servers, Intel provides the backbone for communication between the factory floor and datacenter. In addition, Intel® IoT Gateways enable seamless communication among disparate systems and help securely aggregate and filter data from the factory floor to big data analytics platforms, further supporting the blending of IT, OT, and AT.

Together, Intel and Beckhoff supply the standardized and open technologies required for engineers to implement intelligent production facilities and smart factories in accordance with IoT and Industry 4.0. Both companies understand it is becoming increasingly important that the systems operate not only efficiently, but also flexibly, with optimum vertical and horizontal connectivity options.

The Role of PC-Based Control in Industry 4.0

PC-based control, which often consists of consolidating multiple factory floor workloads onto one ruggedized PC, offers enough flexibility to implement both centralized and decentralized control architectures. Within the field of automation, however, a hierarchical organization will remain the first choice for some time to come, as will I/O systems with reduced intelligence. This concept relies on clearly defined levels, as well as the interfaces between them. The universality of communication will be emphasized more strongly, for example, by assigning an IP address of its own to a limit switch. An automation device will have to provide direct access to web-enabled services in order to reach Industry 4.0.

To realize the promise of this industry transformation, a genuinely holistic approach is needed. Such a strategy should be composed of three key ingredients: 1) horizontal integration across value creation networks, often for multiple companies, 2) vertical integration of networked production systems, and 3) engineering consistency over the entire product life cycle.

This holistic approach, when implemented in close connection with appropriate business management application software, should enable companies to tap into significant potential for optimization as well as additional business models. PC-based control meets the needs of this comprehensive strategy by offering a basic, future-proofed structure that can be flexibly adapted to varying industrial application requirements.

Beckhoff brings decades of experience designing PC-based controllers, and PC control is central to many organizations' Industry 4.0 strategies. With the Beckhoff's software-based Automation Device Specification (ADS), the EtherCAT* Automation Protocol (EAP) and by embracing the OPC UA standard, the company offers excellent options to cost-effectively implement connected solutions that extend from shop floor sensors to the cloud. Intel processor technology helps make this possible by powering the vast majority of Beckhoff's PC-based controllers, an important consideration in Intel's Industry 4.0 strategy.

Beckhoff and Intel also offer tools that combine hardware- and software-level protection to secure and harden PC-based control systems and establish secure connections from the plant floor to the cloud/datacenter and ERP/MES. Via built-in data encryption and security features, OPC UA technology has been adopted by nearly all PLC vendors and MES companies.

What's Next: Intel and Beckhoff Drive Innovation

In order to accelerate Industry 4.0 development, Intel is providing the industry with technologies that can address security and interoperability challenges to enable edge-to-cloud solutions. These solutions include essential Intel building blocks, such as security, gateways, and data management.

Accepted communication standards are a key piece to moving Industry 4.0 closer to reality for more applications. That step will be followed by improvements to the analysis of the newly expanded data streams to bring about enhanced production efficiencies. Real-time changes in product flow, products, machine types, recipes, programs, and more can be made by centralized, PC-based control architectures such as those offered by Beckhoff.

PC-based control is a natural fit for this "IT convergence environment" as PCs are designed to be highly flexible with multiple means of communication to the Internet or local networks thanks to various hardwired or wireless technologies—and because they're always Internet-ready. Even if not initially needed, an IPC, with its inherently superior memory storage capacity and communication capabilities, can be quickly brought into an Industry 4.0 environment, distinguishing it from a traditional "non-PC-based" PLC (Programmable Logic Controller), which is dependent on highly specialized hardware.

Technologies that will help accelerate the evolution to Industry 4.0 include the following:

- Intel® IoT Developer Kit for the IoT that supports a variety of programming environments, tools, hardware, APIs, and cloud connectivity solutions. Based on the Intel® Quark™ SoC X1000, it delivers exceptional performance per watt for those looking for an affordable, single-board controller.
- Low-cost OPC UA servers for communication to MES such as SAP (any Beckhoff PC-based controller can be used as an OPC UA server or client without requiring a hardware add-on)
- Intel® IoT Gateway Development Kit to quickly commercialize IoT products and services. It can be used to create a quick prototype that is reliable and can scale by providing communications, security, manageability, and other key functionality. The kit can also maintain interoperability between new intelligent infrastructure and legacy systems, including sensors and datacenter servers.
- IPCs with Intel multicore processors with more local processing power needed for functions such as condition monitoring, energy management, and highly integrated machine designs, including those that integrate robotics
- TwinCAT 3 with a MATLAB interface to create process simulation environments for virtual commissioning
- The Automation Interface in TwinCAT 3 for remote access to control programs and to dynamically change them based on changes in the production situation
- Automated code creation in TwinCAT 3 (automatic code generation and revision management)

Beckhoff brings a long history of PC-based controller innovation to the industrial sector, and most of those controllers, from IPCs to embedded and panel PCs, rely on advanced Intel processor technology.

Industry 4.0 initiatives will continue to benefit and grow from the variety of communication systems and architectures supported by the PC world. It is this openness that will enable the easy implementation of new, innovative concepts.

Such a reality applies in equal measure to Ethernet and its role as an industrial communication standard. Owing to the extremely high—but by no means exhausted—data transmission rates, Ethernet is now widely accepted throughout the manufacturing industry. Contributing to this evolving role has been the advanced Ethernet-based industrial protocols, EtherCAT and Safety over EtherCAT*. These protocols meet the toughest industry-specific demands for short cycle times, determinism, and efficient safe data communication.

The development of data communication, with ever more complex content and increasing usability requirements, is moving in the same direction: Modern communication is Ethernet-based and is able to meet all requirements created by vertical integration. PC-based control and EtherCAT from Beckhoff are optimally suited to this development.

The Power of Partnership

Developers and customers need a secure and reliable IoT infrastructure, which is why Intel helps ensure deployments satisfy the most critical requirements. Moreover, developers can ensure these needs are met by using development kits from Intel that include critical hardware and software building blocks for IoT.

Beckhoff brings a long history of PC-based controller innovation to the industrial sector, and most of those controllers, from IPCs to embedded and panel PCs, rely on advanced Intel processor technology. By working together, Intel and Beckhoff are helping advance Industry 4.0. They are also equipping industrial companies to make the most of today's changing technological landscape and grow their business.

Success story:

Beckhoff and Intel provide high-end, centralized computing power for Husky

Challenge

Husky Injection Molding Systems Ltd. makes equipment that is used to manufacture a wide range of plastic products, including bottles and closures for beverages and parts for the medical industry. A major trend in the industry is reducing raw material costs, while ensuring top part quality.

To serve this two-pronged goal, Husky prioritizes system accuracy, responsive machinery dynamics, and repeatability when designing injection molding machines. Husky systems are strategically optimized to anticipate and respond to market demands. Through its value-add approach to system design, Husky seeks to provide end users with functionality that can lower total cost to produce, while ensuring best-in-class preform quality.

Solution

Husky introduced the new Husky HyPET* HPP5, the latest evolution of its flexible, high capability preform injection molding system. The HyPET HPP5 relies on high-end computing power delivered by Beckhoff C6930 Industrial PCs (IPCs) equipped with Intel® Core™ i7 processors and running TwinCAT* NC PTP automation software.

Working with Husky, Beckhoff has developed a powerhouse IPC that serves as a multitasking centralized controller, running the HyPET HPP5 system, including all PLC, motion control, measurement, communication to auxiliary devices, and the HMI software. By using one IPC processor to run PLC tasks and another to run the HMI software, Husky has decreased scan times while improving overall quality by establishing real-time control and repeatability of every axis of motion.

Results

The HyPET HPP5 was launched at the end of 2013 and the results are noteworthy. The system provides productivity and cycle time gains from 3 percent to 12 percent, depending on the application. Automation technology, such as consolidating workloads to strike the best balance between quality and efficient use of plastic resources, is a major reason companies choose Husky. The HyPET HPP5 system built on Beckhoff IPCs equipped with Intel Core i7 processors is perfectly positioned to extend this impressive trend.

To learn more, please visit intel.com/industrial or beckhoff.com.

1. Danova, Tony, "Morgan Stanley: 75 Billion Devices Will Be Connected to the Internet of Things By 2020," Business Insider, October 2013.
2. Industry 4.0, Wikipedia.

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