White Paper

Intel® Processors in Industrial Control and Automation Applications

Top-to-bottom processing solutions from the enterprise to the factory floor

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Executive Summary

The factory floor is becoming an increasingly Internet-connected and networked environment. This includes the adoption of systems for remote monitoring, long-distance support, diagnostic services and the integration of in-plant systems with the enterprise. Intel offers top-to-bottom, standards-based silicon solutions for the industrial control and automation market segment that can help manufacturers develop and deliver products for the connected enterprise. These processors include a growing line of Embedded Intel® Architecture processors in addition to several product lines based on Intel XScale® technology. Intel XScale technology-based processors deliver a scalable balance of robust processing performance and low power consumption for applications ranging from industrial control and automation equipment to industrial PCs, intelligent remote-control units, machine vision solutions, building controls and human-machine interfaces.

This paper provides an overview of the key features and benefits of Embedded Intel Architecture and Intel XScale technology-based processors for industrial control and automation applications:

- Embedded Intel Architecture processors and chipsets, including the Ultra Low Voltage Intel® Celeron® M processor and Intel® Pentium® M processor, for high-performance, compute-intensive platforms.
- Intel® IXP42X and Intel® IXP46X network processors for scalable, wired or wireless factory bus/equipment communications with low power consumption.
- The Intel® 80219 General Purpose PCI processor for applications requiring the I/O bandwidth and flexibility of PCI and PCI-X* technology.
- Highly integrated Intel® PXA255 and Intel® PXA270 processors for handheld applications that require graphics, wireless networking capability and multimedia functionality with low power.

Each line of Intel processors is backed by robust development tools and support from Intel as well as a broad selection of complementary, standards-based solutions, tools, building blocks and services from companies in the Intel® Communications Alliance. This rich ecosystem of products and services helps speed time-to-market and improves reliability for developers of industrial automation applications.

Industrial Requirements

The diverse industrial control and automation market segment presents developers with a wide range of requirements including increased processing performance, low power consumption, high I/O bandwidth for data acquisition, scalable storage capability, reliability, long-life support and standards-based connectivity.

Increasing performance requirements are being driven by new compute and graphics-intensive human-machine interfaces and industrial automation applications that connect the modern factory to the Internet. Such “plant-centric” solutions cover a broad range of applications, from design, plant and process engineering to planning and scheduling, operations and maintenance systems.

The need for flexible higher-bandwidth network connectivity is also driving a fundamental shift away from the legacy industrial bus architectures and communications protocols. These architectures and protocols are being replaced by more flexible interconnect technologies, including PCI and PCI-X, and communications protocols, particularly Ethernet, based on industry standards. By enabling the use of commercially available components, the adoption of standards supports simpler and more cost-effective integration of network elements and applications, from the enterprise to the factory floor.

Intel processors for industrial control and automation applications help developers meet the following challenges:

- Industrial control and automation solutions have a spectrum of performance and power requirements. The wide range of Intel processors helps developers deliver the highest performance for a given power budget, including systems that require minimal cooling.
- Intel provides developers with a broad spectrum of standards-based connectivity choices, including building blocks for wired and wireless networking — Gigabit Ethernet and PCI Express* architecture — that enable easy scalability using cost-effective, commercially available components.
- One of the hallmarks of industrial systems is the ability to withstand a wide range of vibration, shock, temperature, humidity, electro-magnetic interference (EMI) and electro-static discharge (ESD) conditions. Ruggedized industrial boards and systems based on Embedded Intel Architecture and Intel XScale technology are available from the extensive group of companies within the Intel Communications Alliance.

- Reliability is another fundamental requirement. Intel is helping drive the development of open modular standards for service-ability, maximum uptime, reliability and high MTBF. Intel plays a leading role in industry-standards bodies including PCI Industrial Computer Manufacturers Group (PICMG*) and the Open Source Development Labs (OSDL*).
- Printers, cameras, scanners, human interface devices and storage subsystems are just some of the peripherals that plug into industrial automation systems. Intel® building blocks provide a variety of connectivity options by supporting flexible, standard interfaces such as USB 1.1 and Hi-Speed USB 2.0. Intel processors and chipsets are also designed to help manufacturers meet a variety of graphics and display requirements.

Time-to-market is also an ever-present challenge for developers of industrial solutions. Intel and members of the Intel Communications Alliance help developers shrink development cycles and minimize costs with silicon and board-level solutions, development tools, software, reference designs and development support services. Embedded and communications providers within the Intel Communications Alliance include board vendors, software vendors and OS vendors who work closely with Intel to develop products and design solutions for the industrial control and automation market segment.

Top-to-Bottom Processing

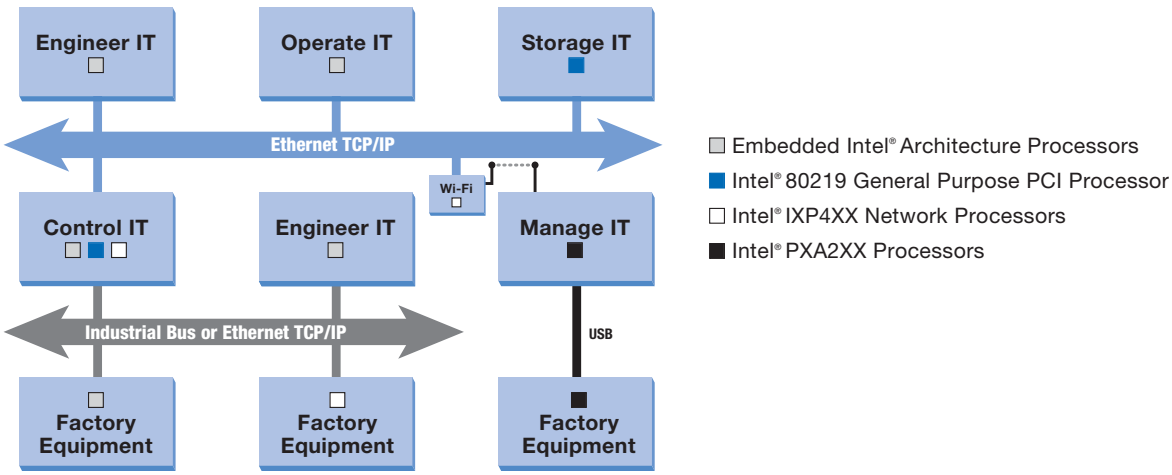
As illustrated in Figure 1, Intel provides processor building blocks for the various functions required in today's connected factory.

Embedded Intel® Architecture Processors

Embedded Intel Architecture processors provide the foundation for a broad spectrum of scalable compute-intensive industrial control and automation platforms, ranging from industrial PCs and servers to ruggedized mobile platforms and single-board computers. Embedded Intel Architecture processors and chipsets provide validated platform configurations that speed time-to-market while providing developers with a roadmap to next-generation capabilities, including the enhanced bandwidth and flexibility of PCI Express architecture.

- Intel Pentium M and Intel Celeron M processors are designed for industrial CompactPCI* and 1U or 2U form factor test and measurement systems and industrial automation applications in space-constrained environments. Offering good performance per watt and Enhanced Intel SpeedStep® technology, the Intel Pentium M processor can consume as little as 6 watts of power when operating at 600 MHz. Enhanced Intel SpeedStep technology enables the processor to scale to higher operating

Figure 1. Intel provides processors for various functions required in today's connected factory



frequency and voltage when an application requires more processing performance. The Intel® 855GME chipset provides dual independent display support and a DDR 333 memory interface with support for error correcting code (ECC). The Intel® 6300 ESB I/O Controller Hub provides PCI-X and Serial ATA interfaces to support the I/O bandwidth requirements of high-end industrial automation applications.

- Intel® Pentium® 4 and Intel® Celeron® D processors are ideal for industrial PC and industrial automation applications that require a combination of high performance and extensive software support. Intel NetBurst® microarchitecture enables the Pentium 4 processor to run at extremely high speeds. This processor also brings powerful new capabilities to the industrial control and automation market segment including a new instruction set (SSE2) for improved graphics performance, higher-bandwidth DDR memory support, ECC support for enhanced reliability, Hi-Speed USB 2.0 support, and SMBus 2.0 for improved manageability.
- Ultra Low Voltage Intel® Celeron® processors are designed for value industrial automation applications that require power in the 6-10 watt range with x86 software compatibility.

Intel® 80219 General Purpose PCI Processor

The combination of a 32-bit local bus, DDR memory controller technology and a fast internal memory bus make the Intel 80219 General Purpose PCI processor ideal for applications that require high data bandwidth, including CompactPCI data-acquisition devices. The Intel 80219 processor includes a high-speed (400 or 600 MHz) 32-bit Intel XScale core with a 64-bit PCI-X interface and a 200 MHz DDR SDRAM controller with ECC, capable of supporting up to 1 GByte of 64-bit DDR SDRAM. The processor also includes a programmable 32-bit local bus for flexible connections to non-PCI peripheral components including ASICs, flash memory devices and digital signal processors. The PCI/PCI-X bus allows the addition of peripheral devices such as Gigabit Ethernet controllers.

Intel® IXP4XX Network Processors

Intel IXP4XX network processors are ideal for industrial control and automation applications that require mid to high performance, wired or wireless Ethernet connectivity, extended temperature support, low-power (< 2W) operation and small form factor design.

- The Intel IXP42X product line is available in core speeds of 266, 400 and 533 MHz. Integrated features include10/100 Ethernet MACs, USB Controller, high-performance PCI interface, UTOPIA-2 interface, two high-speed serial (HSS) interfaces and an IPSec-enabled hardware security engine.
- The Intel IXP46X product line includes all the integrated features of the Intel IXP42X product line with an additional core speed of 667 MHz and the following features:
  - DDR interface with ECC support for high reliability
  - IEEE 1588* hardware assist for time synchronization of Ethernet packets
  - USB host interface for connectivity to peripherals including print servers, hard disk drives, controller interfaces and field debug services
  - Expansion bus with external mastering capability for connecting to external devices, ASICs and custom chips that can communicate directly with each other and with internal peripherals
  - I^2C interface for connection to various embedded devices
  - SSP interface for connection to Analog to Digital Converters (ADCs) and Digital to Analog Converters (DACs)

Intel® PXA2XX Processors

Highly integrated Intel PXA2XX processors provide the ideal processing solution for small form factor industrial handheld devices that require a combination of high performance, low power and long battery life, with support for a graphics display and user interface.

- The Intel PXA255 processor is available in core speeds of 200, 300 and 400 MHz. Integrated features include an LCD controller, MM/SD and CompactFlash* card interface and USB 1.1 client capability.
- The Intel PXA270 processor includes all the features of the Intel PXA255 processor with core speeds of 312, 416, 520 and 624 MHz, Intel® Wireless MMX™ Media Enhancement Technology, USB 1.1 host/OTG connectivity, an integrated camera interface and additional low-power modes.

The high MIPs/watt ratio and high level of integration of Intel PXA2XX processors makes them ideal for reducing the design complexity for interactive handheld applications.

Tools and Support

Intel and the Intel Communications Alliance ecosystem provides developers with the advantages of a broad selection of silicon, software, development tools and support to enable faster time-to-market and more reliable solution deployment. Specific advantages from Intel and the Intel Communications Alliance ecosystem include:

- Support for embedded product life cycles, with minimum availability of five years.
- Technical information and support for developers from design through manufacturing.
- Reference and evaluation platforms for fast time-to-market designs.
- Support for multiple real-time and PC-based operating systems.
- Software solutions including drivers, application software and tools optimized for Embedded Intel Architecture and Intel XScale technology.
- Flexible, modular designs for multiple embedded form factors including ATX, PC-104, EBX, VME, CompactPCI, AdvancedTCA,* Flex ATX, EmbeddedATX, Micro ATX and COM Express.*
- Scalability to meet future processing requirements, supported by strong processor roadmaps.

Conclusion

The industrial control and automation market segment presents manufacturers with a spectrum of opportunities, from sophisticated networked applications on the factory floor to the connected enterprise. Intel offers top-to-bottom, standards-based silicon solutions that help developers of industrial systems meet a broad range of demanding application requirements. See Table 1 for a summary of how Intel processors align with various industrial control and automation applications and functions.

Intel provides developers with a choice of multiple processor lines that provide the performance, low power, I/O bandwidth, reliability and integrated connectivity required to meet today's development challenges. Embedded Intel Architecture and Intel XScale technology-based processors span an extensive power and performance range, from processors that consume approximately 300 mW of power to high-performance embedded processors with clock speeds greater than 3 GHz. Intel's commitment to developers in industrial control and automation is reflected in product lines with embedded lifecycle support, development tools and standards-based building blocks that support quick time-to-market, backed by an extensive selection of ecosystem solutions and services from the Intel Communications Alliance.

Table 1. How Intel® processors align with specific industrial functions and applications

Intel® Processors	Industrial Control and Automation Applications and Functions
Embedded Intel® Architecture processors	Compute-intensive applications: ■ Industrial PCs ■ Ruggedized laptops ■ Single-board computers
Intel® 80219 General Purpose PCI processor	High-bandwidth, flexible-attach CompactPCI* solutions: ■ Intelligent shelf management ■ Data acquisition and analysis ■ System data storage
Intel® IXP42X and IXP46X network processors	Connects factory bus/equipment to enable: ■ Industrial bus to Ethernet communication (wired or wireless) ■ Factory equipment/communication control
Intel® PXA255 and PXA270 processors	Portable handheld devices for: ■ Warehouse inventory ■ Portable data acquisition ■ Real-time equipment diagnostics

Where to Learn More

- For details about Embedded Intel Architecture processors in industrial automation, visit **http://www.intel.com/design/intarch/roadmap.htm**.
- For details on Intel IXP4XX network processors, visit **http://www.intel.com/go/networkprocessors**.
- For details on the Intel 80219 General Purpose PCI processor, visit **http://www.intel.com/design/iio/80219.htm**.
- For details on Intel PXA2XX processors, visit **http://www.intel.com/design/embeddedpca/applicationsprocessors/index.htm**.
- For details on the Intel Communications Alliance, visit **http://www.intel.com/go/ica**.

Contact your Intel representative for assistance with your next industrial control and automation solution.

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