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Intel Entry Processors: The Right Balance of Performance and Power for the Industrial IoT Market

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Introduction

The current manufacturing industry amidst the Fourth Industrial Revolution (IR 4.0) is highly dynamic, with rapid changes and new technologies emerging constantly. Manufacturers are progressively turning to automation and digital technologies to improve efficiency, reduce costs, and increase productivity.

Robotics are increasingly being used in automation to perform complex or dangerous tasks, and machine learning and artificial intelligence (AI) are being adopted to improve the performance and decision-making capabilities of automation systems. Furthermore, the Internet of Things (IoT) has been embraced to link and control automation systems, allowing for different systems and devices to work together without disruption and better control and monitoring of processes.

Intel recognizes the challenges and concerns faced by the industry in adopting the latest technologies to move towards greater automation and digitalization. And for that, Intel has been constantly developing and introducing various products that suit industrial players at different levels and scales.

Among Intel's vast range of industrial-grade solutions, Intel Atom® x7000E Series, Intel Processor N-series and Intel Core™ i3 N-Series Processors (previously codenamed as Alder Lake-N) are its line of latest generation processors specifically designed to facilitate the initiation of automation and digitalization for factory operations, and they come with a good balance of low power and high performance for entry level applications, pairing with real-time, AI, security features, and high-speed I/Os, making the leap to IR 4.0 a feasible.

Intel Atom® x7000E Series, Intel Processor N-Series and Intel Core™ i3 N-Series Processors

Intel Atom® x7000E Series, Intel Processor N-Series and Intel Core™ i3 N-Series Processors are a family of low-power x86 Intel entry processors which integrate a rich set of IoT features. Compared to its predecessors, this generation delivers up to 1.30x faster single-thread performance and up to 1.09x faster multi-thread performance. Also, Intel® UHD integrated graphics provides up to 1.68x performance improvement1. This series also supports Intel® AVX2 and Deep Learning Boost technology to provide accelerated deep learning inference and media processing to edge applications like machine vision and robotics.

As part of the x86 Intel processor solutions enhanced for IoT platform, Intel Atom® x7000E Series, Intel Processor N-Series and Intel Core™ i3 N-Series Processors share the same architecture as the higher-end 13th Gen Intel® Core™ processors and Xeon® processors, making it easier for users to port between applications and solutions across CPU performance and power range. While being a power-efficient processor, Intel entry processors have similar IoT features as the higher-scale processors.

A summary of the key features of Intel Atom® x7000E Series, Intel Processor N-Series and Intel Core™ i3 N-Series Processors is as follows:

Excellent Computing Power	**Real-Time Computing for High Performance with Determinism in Time**	**Exceptional UHD Graphics with Xe Architecture**	**Support Hardware Virtualization for Workload Consolidation**
Up to 8 E-cores	Enabled by Intel® TCC and a 2.5 GbE Time Sensitive Networking capable integrated MAC on the platform controller Hub (PCH)	Supporting up to 3 4K60 displays with up to 32 execution units	Through Intel® Virtualization Technology, maximizing resource utilization

Tuned for AI Inference	**Management and Security**
- Intel® Advanced Vector Extensions 2 Vector Neural Network Instructions (Intel® AVX2 VNNI) and Intel® Deep Learning Boost2 (Intel® DL Boost) to accelerate deep learning inference - Intel® Distribution of OpenVINO™ toolkit for cross-architecture deep learning inference - Intel® UHD Graphics driven by Xe architecture for parallel processing of AI workload - Intel® Edge Insights for Industrial (EII) video and time series data analysis	- Intel® OS Guard, Intel® Boot Guard, Intel® Platform Trust Technology (PTT), and many more, providing platform integrity and data protection, as well as hardware-assisted crypto acceleration
	High-Speed I/Os: 6xUSB3.2, 8xUSB2.0, 9x PCIe, 1x2.5 GbE TSN, 2xSATA, 9xI2C

Accompanied with Intel's robust hardware and wide range of software and development tools, Intel Atom® x7000E Series, Intel Processor N-Series and Intel Core™ i3 N-Series make it easier for developers to create and deploy Industrial AI solutions with up to 6.85x faster GPU object detection inference performance1. Furthermore, they also come with formidable software support as follows:

Software Support			
Category	**Operating Systems / SDKs / Bootloaders/Hypervisors**	**Implementation**	**Distribution and Support**
Operating Systems[1]	Windows*[6] 10 IoT Enterprise LTSC 2021	Intel	Intel, Microsoft*
	Ubuntu*[3], RHEL*[3], WR Linux*[3]	Canonical Ltd., Red Hat & Wind River Systems	Distributed and supported by commercial Linux* vendors; **Intel upstream kernel drivers**
	Yocto Project* (LTS kernel 2021)	Intel	Intel, Yocto Project* community, Linux* ISVs
	Celadon CiV (Android* optimized for IA)	Intel	Celadon open-source community, ISV Partners
RTOS	Wind River VxWorks*, **QNX***	Wind River, Blackberry	Wind River, Blackberry QNX
	Zephyr[4] RTOS	Intel	Zephyr* open-source community
Hypervisors	**KVM*[3]**, ACRN*[3]	KVM*, ACRN*	KVM*, ACRN* open-source community
	Real-Time Hypervisor	Real-Time Systems GmbH	Real-Time Systems GmbH
Boot Firmware[2]	UEFI/BIOS and Intel® FSP	Intel	Intel BIOS Vendors (IBV)
	Slim Bootloader and Intel® FSP	Intel	IBootloader Ecosystem & SBL community
SDK	Intel® oneAPI (base[5] & iot toolkits)	Intel	Intel
	OpenVINO™	Intel	Intel

[1] Not all features are supported in all Operating Systems
[2] Legacy boot is not supported. Customers should work with their BIOS vendors for enabling/validating legacy BIOS features.
[3] Supported by Intel via the upstreaming to open-Source Community. Adoption into individual Linux* distributions/hypervisors is dependent upon the OS/HV vendors.
[4] Planned Post PV
[5] OneAPI base toolkit includes VPL (Video Processing Libraries, formerly Intel Media SDK)
[6] Includes EFLOW (Azure IoT Edge For Linux On Windows)
* Other names and brands may be claimed as property

Industrial Use Cases

Intel Atom® processors are widely used in industrial applications, such as robotics and control systems (Programmable Logic Controller (PLC), motion controller, etc.), in which they can provide reliable and efficient performance for various automation tasks. Another prevalent application is powering embedded computing systems, such as Industrial PCs, Panel PCs, and HMIs, allowing for real-time data analytics, decision-making, and control of automation processes. Besides, they can be used to power machine learning and AI systems, allowing for smarter and more efficient automation processes.

Popular Use Case Example: Programmable Logic Controller (PLC)

A programmable logic controller (PLC) is a computer used in industrial automation applications to control machines and processes and automate tasks. It is designed to be rugged, reliable, and efficient, as well as optimized for real-time operations. Therefore, CPUs used in PLCs must be fast, reliable, and energy-efficient. In increasingly more cases, a single physical system would host multiple virtual PLCs by workload consolidation, providing improved scalability and cost savings. The number of virtual PLCs run on a single system, however, depends on the performance of the processor – a higher-performance processor can support more workloads. In this regard, Intel Atom® x7000E Series, Intel Processor N-Series and Intel Core™ i3 N-Series Processors have all the necessary features to support the deployment and application of multiple PLCs.

- **Power-efficient, high-performance processor** to support workload consolidation to help reduce hardware costs, improve scalability, and increase efficiency. This processor family offers SKUs as low as 6W, which meet the low-power and fanless requirements in factories and provide excellent performance/watt needed for PLCs.

- **Real-time technologies** provide ultra-reliable low latency connectivity, interoperability, and communications between machines. This processor family offers excellent real-time performance achieved by Intel® TCC.

- **Software support** for better controls in automation. This processor family comes with support for industrial reference solutions, such as Intel® Edge Control for Industrial (ECI) and Intel® Edge Insights for Industrial (EII). These processors also provide software development support, including TSN Reference Software, Intel® Distribution of OpenVINO™ toolkit, and Intel® OneAPI toolkit. They also support various real-time operating systems (RTOS), which are essential for the real-time operations of PLCs.

- **Inference workloads** with the support of Intel® AVX2 and Deep Learning Boost technology2 bring accelerated deep learning inference and media processing capability to edge applications like machine vision and robotics.

Conclusion

Intel Atom® x7000 Series, Intel Processor N-Series and Intel Core™ i3 N-Series Processors are great choices for industrial applications that require low-power solutions for automation and digitalization deployment because of their remarkable performance efficiency, real-time capability, breadth of operating system and software support, and scalability.

References and Sources:

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