The series provides software flexibility, supports deterministic performance, and enables faster time to market when running a combination of industrial and IoT applications on Intel® Core™ vPro™ processors.

Product Overview
A growing trend in industrial automation is to use virtualization technology to combine what were previously discrete subsystems into a single system. The Intel® Industrial Solutions System Consolidation Series greatly simplifies this effort by pre-integrating key virtualization software onto platforms based on 4th generation Intel® Core™ vPro™ processors, thus reducing development time for original equipment manufacturers (OEMs). In addition, the flexibility of the software makes it easy to consolidate Internet of Things (IoT) and industrial workloads in ways that help industrial customers gain greater insight from data.

For OEMs building multi-function industrial PCs, Intel Industrial Solutions System Consolidation Series software can be used to run an assortment of industrial and IoT workloads on a single platform. It is a production-ready, virtualization software stack supporting real-time, embedded, and general-purpose operating systems, which gives equipment suppliers a great deal of flexibility to include IoT gateway, firewall, control, and other applications shown in Figure 1. Systems incorporating this solution enable industrial customers to reduce cost and complexity because multiple factory functions are consolidated, thus decreasing operating expense, factory footprint, energy consumption, and integration and support effort.

The Internet of Things helps industrial customers get more out of their assets

The system consolidation software runs on a family of 4th generation Intel Core vPro processors that feature Intel® Virtualization Technology (Intel® VT). This combination delivers the computing performance needed to simultaneously host multiple instances of the Wind River* VxWorks* RTOS and Wind River Linux* 7.0, as well as one instance of Microsoft* Windows* 7. Also included is McAfee Embedded Control – a “deploy-and-forget” security solution with a small footprint and low overhead.

Figure 1. Various Applications Running in a Virtualized Environment
System Consolidation Series Kits

- **Development kit**: provides software, documentation, and a Wind River Workbench* development environment for engineers looking to accelerate and simplify their system development.

- **Production kit**: contains software entitlements and licenses that allow OEMs building consolidated industrial computing devices to deploy their solution with the System Consolidation Series runtime software.

Software Flexibility

Equipment suppliers are in an ideal position to help industrial customers deal with the deluge of factory data by adding IoT workloads, like gateway, protocol normalization, and data analytics, to their automation products. An efficient and cost-effective approach is to consolidate industrial and IoT applications onto a single computing platform with virtualization technology.

Today, some industrial control systems require multiple boards in order to support multiple applications, like a soft programmable logic controller (PLC), motion control, machine vision, and HMI – each with different sets of requirements. PLC and motion control are time-critical applications best served by a real-time operating system (RTOS) that delivers deterministic performance. On the other hand, developers of HMI applications may prefer to use a general-purpose operating system (GPOS), like Microsoft Windows, which comes with tools that ease the development of touch screen displays, rich graphics, and multimedia.

Moving forward, Figure 2 shows how the Intel Industrial Solutions System Consolidation Series can help address these requirements, as well as support an IoT gateway on Linux. This is because a combination of real-time, embedded, and general-purpose operating systems can run in virtual machines (VMs) on Wind River Virtualization Profile for VxWorks, which is a hypervisor that enables near-native performance. In other words, users can set up the combination of VMs they want. This software flexibility enables equipment suppliers to quickly tailor a solution to satisfy new customer requests and changing market requirements.

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Figure 2. Sample Solution Using the Intel® Industrial Solutions System Consolidation Series

1 McAfee Embedded Control for Wind River Linux 7 is a future planned enhancement for the product.
Deterministic Performance
What distinguishes the Intel Industrial Solutions System Consolidation Series from other virtualization software stacks is the flexibility system developers have to tune performance via a simple, user-editable script. For each VM, it is possible to allocate a specific amount of system memory, and assign I/O devices and processor cores, as illustrated in Figure 3. With this capability, equipment suppliers can also perform load balancing to improve system utilization.

A VM can share a processor core with other VMs or have its own core. I/O devices cannot be shared among VMs. The performance of a VM can typically be increased by giving it more memory and one or more dedicated processor cores, which is advised for a real-time application that requires low latency. This configuration can increase the determinism of a time-critical application by allowing it to run essentially unencumbered by other applications running on other processor cores.

Faster Time to Market
Since the virtualization software components ship with the system consolidation series kit, developers and production managers do not have to spend time finding the appropriate software components and negotiating licensing terms with all the various software providers. Pre-integrated, validated, and tested, the development kit works right out of the box and eliminates high, upfront engineering costs by including development tools, hypervisor, and operating systems. The solution is also validated to work with Microsoft Windows, which must be purchased separately.

Hardware-Assisted Virtualization Technology
Although virtualization is generally viewed as a software technology, Intel has added hardware features to its processors to improve the performance and security of virtualization. This hardware-assist technology, called Intel VT, enhances the capabilities of software-based virtualization technology. It performs various virtualization tasks in hardware, like memory address translation, which reduces the overhead and footprint of virtualization software and improves its performance, security, and reliability. For instance, VM to VM switching time is significantly faster when memory address translation is performed in hardware instead of by software.

In addition, Intel VT increases the robustness of virtualized environments by using hardware to prevent the software running in one VM from interfering with the software running in another VM. Along these lines, virtualization helps avoid unintended interactions between applications by preventing one from accessing another’s memory or I/O space.
Software Elements Included

The software components in the Intel Industrial Solutions System Consolidation Series development and product kits are listed in Table 1 and described in the following.

Wind River* Virtualization Profile for VxWorks* — Embedded Virtualization

Virtualization Profile for VxWorks extends the scalability capabilities of VxWorks by integrating a real-time embedded, Type 1 hypervisor into the core of VxWorks. Through embedded virtualization, the VxWorks hypervisor allows customers to combine multiple workloads on a single multi-core Intel® processor. Virtualization Profile enables customers to meet the challenges of the IoT era, where connectivity, scalability, and security are required.

Wind River* VxWorks* RTOS — Real-Time Performance

Wind River VxWorks RTOS provides scalability, reliability, and real-time performance, along with deterministic behavior. Key features include a tunable memory footprint, hard real-time performance, state-of-the-art memory protection, advanced multi-core processor support, and extensive connectivity options. Together, these features deliver the capabilities and support demanded by mission-critical, connected, intelligent systems.

Wind River* Linux* 7.0 — Embedded Linux

Wind River Linux 7.0 is a commercial-grade Linux solution for embedded device development. Wind River Linux combines the necessary elements to enable customers to build and support highly-differentiated devices: an optimized run-time; a flexible, scalable build system; pre-integrated middleware packages for specific device types; an integrated development environment; and an open-source toolkit, adapted and extended for embedded development.

McAfee Embedded Control

End users can prevent the execution of malware, like the Stuxnet worm, by controlling what runs on their industrial systems and protecting the memory in those devices. This is achievable when industrial IT departments are able to specify exactly which programs (e.g., exes, dlls and scripts) are permitted to execute, a capability supported by McAfee Embedded Control with whitelisting. It automatically creates a whitelist of the “authorized code” on the embedded system. Once the whitelist is created and enabled, the system is locked down to the known good baseline, no program or code outside the authorized set can run, and no unauthorized changes can be made. Whitelisting prevents worms, viruses, spyware, and other malware from executing illegitimately on industrial systems.

Wind River* WorkBench* - Development Environment

To help developers port their applications to the multi-OS platform, the development kit provides the Wind River Workbench development environment. Workbench accelerates application development, helps reduce device code complexity, improves code quality, and shortens time spent in test cycles. Using native Eclipse* integration capabilities, Workbench enables developers to take advantage of home-grown or commercial plug-ins for application design, development, and test to further speed application development and reduce time-to-market.

### Table 1. Intel® Industrial Solutions System Consolidation Series SKUs

<table>
<thead>
<tr>
<th>Components</th>
<th>Development Kit (integrated components)</th>
<th>Production Kit (non-integrated components)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Software:</td>
<td>Downloadable</td>
<td>Runtime licenses</td>
</tr>
<tr>
<td>- Wind River Virtualization Profile for VxWorks 7</td>
<td></td>
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<tr>
<td>- Wind River Linux 7 (64-bit)</td>
<td></td>
<td></td>
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<tr>
<td>- Wind River VxWorks 7 (32/64 bit)</td>
<td></td>
<td></td>
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<tr>
<td>- McAfee Embedded Control for Windows*</td>
<td></td>
<td></td>
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<tr>
<td>- McAfee Embedded Control for Linux†</td>
<td></td>
<td></td>
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<tr>
<td>Wind River Workbench* Development Environment</td>
<td>*</td>
<td></td>
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<tr>
<td>Documentation and tutorials</td>
<td>*</td>
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</tbody>
</table>

† McAfee Embedded Control for Wind River Linux 7 is a future planned enhancement for the product.
Industrial system consolidation offers a powerful path forward for industrial customers looking to minimize costs and support effort while conserving valuable factory floor space. Along these lines, virtualization technology running on 4th generation Intel Core vPro processors helps reduce cost and complexity through the consolidation of computing devices for motion control, PLC, HMI, machine vision, data acquisition, safety, control, and so forth. At the same time, this powerful combination allows equipment suppliers to add IoT applications, like gateways and data analytics, that help industrial customers collect and make sense of factory data. The Intel Industrial Solutions System Consolidation Series, available as development and production kits, can dramatically lower risk and speed up the development of consolidated systems using virtualization technology.

Benefits from Consolidation
By consolidating devices using virtualization technology, original equipment manufacturers (OEMs) developing industrial automation solutions can provide substantial benefits to their customers, such as:

- **Lower overall solution cost**: A consolidated device should cost less to manufacture than the combined subsystems because it has a smaller bill of materials (BOM).
- **Reduced integration cost**: Integration is simplified since the networking, cabling, shielding, and configuration, etc., that connect multiple subsystems together are handled within the system.
- **Smaller factory footprint**: Consolidated equipment takes up less factory floor space than the individual systems it replaces.
- **Reduced overall energy consumption**: The power efficiency of Intel® Core™ vPro™ processors, combined with system consolidation, can yield a solution that consumes less power than the individual systems combined.
- **Simpler to secure**: There are fewer systems to secure; the attack surface of the factory is reduced; and potentially, there is a smaller variety of security solutions to support.
- **Higher reliability**: A consolidated system should have a better mean time between failures (MTBF) than a combination of subsystems it replaces because there are fewer points of failure.
- **Easier system management**: Factory IT personnel have a smaller number of devices to install, provision, and manage, and fewer spares to inventory.

For more information about Intel solutions for industrial automation, visit [www.intel.com/industrial](http://www.intel.com/industrial).

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1 Results have been estimated based on internal Intel analysis and are provided for informational purposes only. Any difference in system hardware or software design or configuration may affect actual performance.

2 Intel® Virtualization Technology (Intel® VT) 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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