SOLUTION BRIEF

Industrial IoT (IIoT)
Embedded Software and Systems

Real-Time Systems and Intel take industrial embedded systems to the next level

Innovative hypervisor and partitioning software increases flexibility and functionality for industry

Executive summary

The Industrial IoT (IIoT) has the potential to bring increased optimization, automation, and insight to industrial facilities. But frequently, proprietary, incompatible equipment and systems—combined with the need to meet complex, time-based, deterministic requirements—make realizing this potential challenging. Real-Time Systems (RTS) software running on robust, high-performance Intel® architecture enables the creation of intelligent embedded applications for IIoT, enabling benefits from holistic visibility into operations to centralized equipment management and maintenance.

Challenges

Industrial operations are inherently time based—they require processes and procedures to occur in a predefined linear sequence with little margin for error. Furthermore, equipment and systems built for industry are often proprietary, using incompatible protocols and networks not designed to work together or to allow for centralized management or maintenance.

Typically, coordinating timed workflows and gathering data on performance and usage requires at least two computers, one servicing an application's real-time needs, the other running a general-purpose operating system (GPOS) such as Linux* or Windows*. In such a configuration, the GPOS is responsible for data processing, visualization, and integration of applications into the facility's networks. The result is often costly and makes it difficult to obtain a holistic, accurate view of ongoing operations or to increase automation and preventive maintenance.

Solution

Real-Time Systems (RTS) brings in-depth expertise in hypervisor and embedded virtualization technology to simplify and speed development and deployment of market-ready, standardized software products targeting advanced embedded applications.

RTS software running on robust, high-performance Intel architecture enables industrial embedded applications that support an array of critical capabilities, including deterministic, real-time performance, data processing, visualization, and seamless connectivity. The solution is helping industry to advance automation while improving data acquisition (for instance, via motion control and programmable logic controllers [PLCs]).

REAL-TIME SYSTEMS GMBH

Deployment of multiple operating systems on multicore processor platforms is a logical step in embedded system design, reducing total hardware costs while increasing reliability and system performance. The innovative Real-Time Systems Hypervisor permits multiple real-time operating systems (RTOS) and general-purpose operating systems (GPOS), such as Windows or Linux, to run concurrently on multicore Intel® processors.

Through the RTS Real-Time Hypervisor, modern multicore processor platforms, such as the Intel Atom®, Intel® Core™, and Intel® Xeon® Scalable processors, can execute multiple operating systems independently of one another on a single platform. The RTS Real-Time Hypervisor can also assign individual processor cores, memory, and devices to each operating system. Through a configuration file, the boot sequence can be specified and, when desired, one operating system can be rebooted independently of any others. In order to facilitate communication between operating systems, the RTS embedded virtualization solution also provides a configurable user-shared memory, an event system, and a TCP/IP-based virtual network.

Use cases

RTS solutions powered by Intel architecture are deployed in a wide range of industrial implementations and use cases.


Industrial automation


Telecommunications


Medical


Instrumentation


Test and measurement


Defense process control


Aerospace


Multimedia


Electronics

Get the benefits of Industry 4.0

Industrial decision-makers and operations managers

The RTS product works out of the box without customization.

Industrial application developers

RTS products give real-time system developers up-to-date solutions for substantial portions of embedded projects, accelerating development and time to market.

Industrial equipment manufacturers

The powerful, cost-effective RTS software solution powered by Intel architecture offers increased flexibility in system design and enhanced functionality and performance, while reducing overall system cost.

Advancing edge and cloud intelligence

Intel and its ecosystem help businesses use the IoT to solve long-standing industry-specific challenges. Quickly develop IoT solutions that connect things, collect data, and derive insights with Intel's portfolio of open and scalable solutions so you can reduce costs, improve productivity, and increase revenue.

Intel technologies support the rigorous requirements for programmable logic controllers (PLCs), industrial PCs (IPCs), human machine interfaces (HMIs), robotics, machine vision, and many other industrial applications.

Real-Time Systems Hypervisor key features and benefits

Simplified out-of-the-box deployment	• Ready to use out of the box • Users can install and configure the RTS Hypervisor independently, without detailed hardware knowledge • Considerable savings on non-recurring engineering (NRE) costs • Easy evaluation of the RTS Hypervisor on any x86 platform
Flexible	• When functions are separated among virtual machines, the collaboration between these virtual machines remains highly flexible • Create new combinations on the basis of open standard interfaces at any time • No hardware-specific modifications required • Support for all Intel® CPUs • Easy communication via high-performance internal virtual network (TCP/IP) • Mix and match operating systems
Scalable	• Scales from Intel Atom® processors to multiple node non-uniform memory access (NUMA) servers
Efficient use of resources	• Make better use of the overall hardware capacity than when each operating system is allocated a dedicated system • Lower costs and energy consumption • Run a real-time operating system without adding extra latencies (0.00 µs) • Retain performance and determinism of real-time applications • Designed for rugged real-time use • Time synchronization between operating systems • High-performance event system
More secure	• Measured and secure boot is possible • No backdoors—operating systems securely separated
Reliable	• When the number of hardware components is reduced, the probability of failure of the overall system decreases (e.g., by consolidating an industrial PC-based HMI and an ARM or microcontroller-based real-time control into a single hardware platform, the mean time between failures [MTBF] can be significantly increased) • Lower maintenance costs • Higher productivity with less downtime • Increase user satisfaction
Software-defined	• Shared memory with easy-to-use API which can be configured for direct data exchange • APIs to monitor, start, and stop guest operating systems • Rights management for all APIs and shared memories
Tested	• Highly secure design with no backdoors or interfaces into the hypervisor • Tested and deployed with customers worldwide • Proven in thousands of applications globally
Simplified certification	• Use the RTS Hypervisor to separate security-critical from noncritical areas to make the development process and functional validation more efficient, and to simplify quality assurance and certification • Modularize applications and make changes in one module without having to recompile and completely retest the other software components • Reduce time to market and costs
Industry 4.0 ready	• Standalone partitions for a dedicated security gateway with network function virtualization (NFV) for firewall, virus protection, and routing help to significantly increase security and eliminate the need for additional gateways • Real-time applications can be connected quickly and efficiently, while adapting the IoT and Industry 4.0 gateway to meet specific requirements

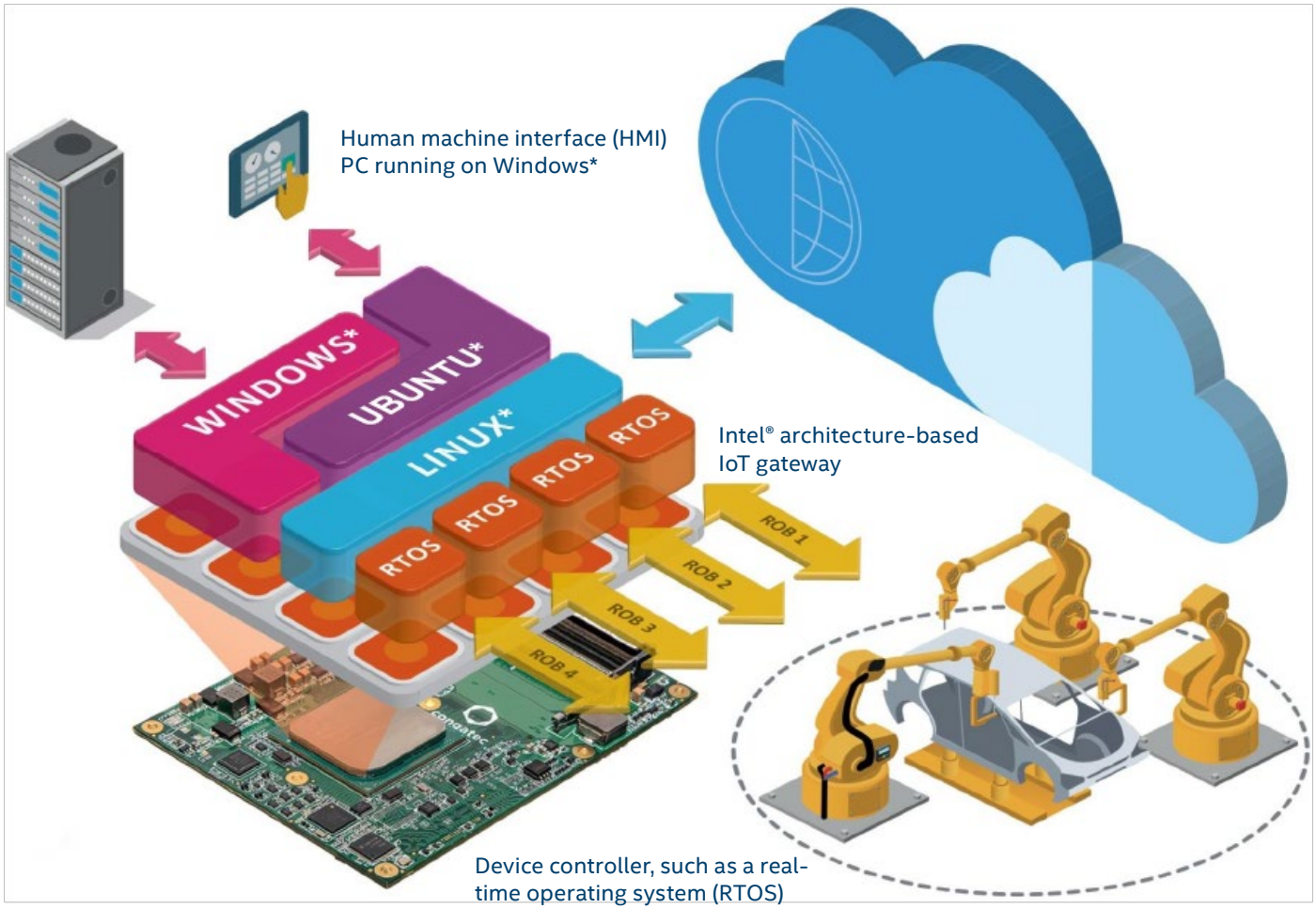

Figure 1. RTS and Intel enable hypervisor consolidation targeted to industrial implementations utilizing standardized building blocks

How it works in brief

RTS Real-Time Hypervisor

The RTS Real-Time Hypervisor enables modern, multicore Intel processors with Intel® Virtualization Technology (Intel® VT) to simultaneously run either multiple instances of a real-time operating system or a heterogeneous mixture of 32-bit or 64-bit operating systems on a single execution platform. All systems are safely separated, run in real-time, and can even reboot without disturbing the execution of other operating systems.

Out of the box, the hypervisor supports Windows® 10 and older, Windows Embedded Compact, VxWorks*, RTOS-32*, QNX*, OS-9, Linux and real-time Linux, RedHawk*, and T-Kernel. Support for other operating systems or proprietary real-time code can be added at any time upon request.

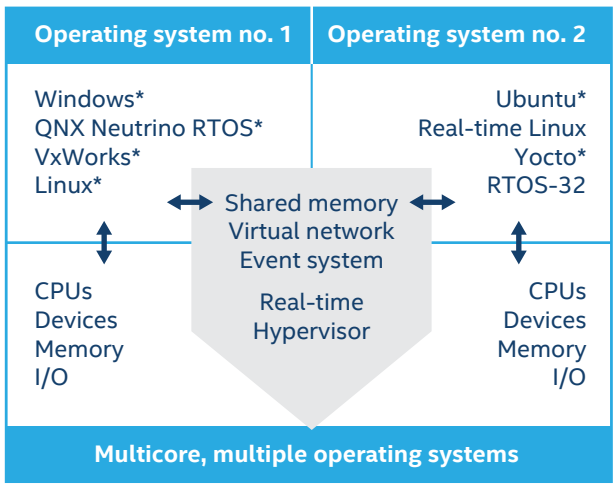

Figure 2. RTS Real-Time Hypervisor powered by Intel® architecture

Technical features

- Run multiple instances of an RTOS or a mix (e.g., Windows* and RTOS)
- Completely independent execution of operating systems
- 100 percent separation of operating systems in memory
- No latencies (0 µs) added for RTOS
- Direct hardware access
- Exclusive resource allocation (supports xHCI and AHCI sharing)
- Use standard drivers
- Includes virtual network driver for seamless TCP/IP communication
- Definable boot sequence; reboot any system, anytime
- Simple installation and configuration
- Multiple OS runtimes per guest OS
- Microcode updates possible by hypervisor
- xHCI controller sharing (port assignment)
- AHCI controller sharing (disk or partition assignment)
- Cache Allocation Technology (CAT) for L3 caches (Intel® Core™ processors and Intel® Xeon® processors)
- CAT support for shared L2 caches found on Intel Atom® processors
- Support for measured boot and secure boot
- Access rights management for shared memory
- Access rights for all APIs to monitor, start, and stop guest operating systems
- Virtual MMU and IOMMU configurable for secure hardware separation of operating systems

The foundation for IoT

The RTS solution is just one example of how Intel works closely with the IoT ecosystem to help enable smart Internet of Things (IoT) solutions based on standardized, scalable, reliable Intel® architecture and software. These solutions range from sensors and gateways to server and cloud technologies to data analytics algorithms and applications. Intel provides essential end-to-end capabilities—performance, manageability, connectivity, analytics, and advanced security—to help accelerate innovation and increase revenue for enterprises, service providers, and industry.

Conclusion

With RTS and Intel, developing and deploying intelligent applications for embedded and real-time systems is simplified, allowing industry to accelerate the benefits of IIoT while meeting the demands of time-based, deterministic compute.

About Real-Time Systems GmbH

RTS, a congatec company, is a global manufacturer of hypervisor technology specializing in real-time virtualization. RTS hypervisor solutions support all popular operating systems for x86 architecture. The company was founded in 2006 as a spin-off of KUKA, active in various industries worldwide, and headquartered in Ravensburg, Germany.

real-time-systems.com

Learn more

For more information about the RTS Hypervisor, please visit **real-time-systems.com** or contact us at **info@real-time-systems.com**.

For more information about Intel® IoT Technology and the Intel IoT Solutions Alliance, please visit **intel.com/iot**.

0418/GR/CMD/PDF 337501-001US