

Introduction to workload consolidation

An effective way to reduce costs and complexity
in embedded applications

Whitepaper

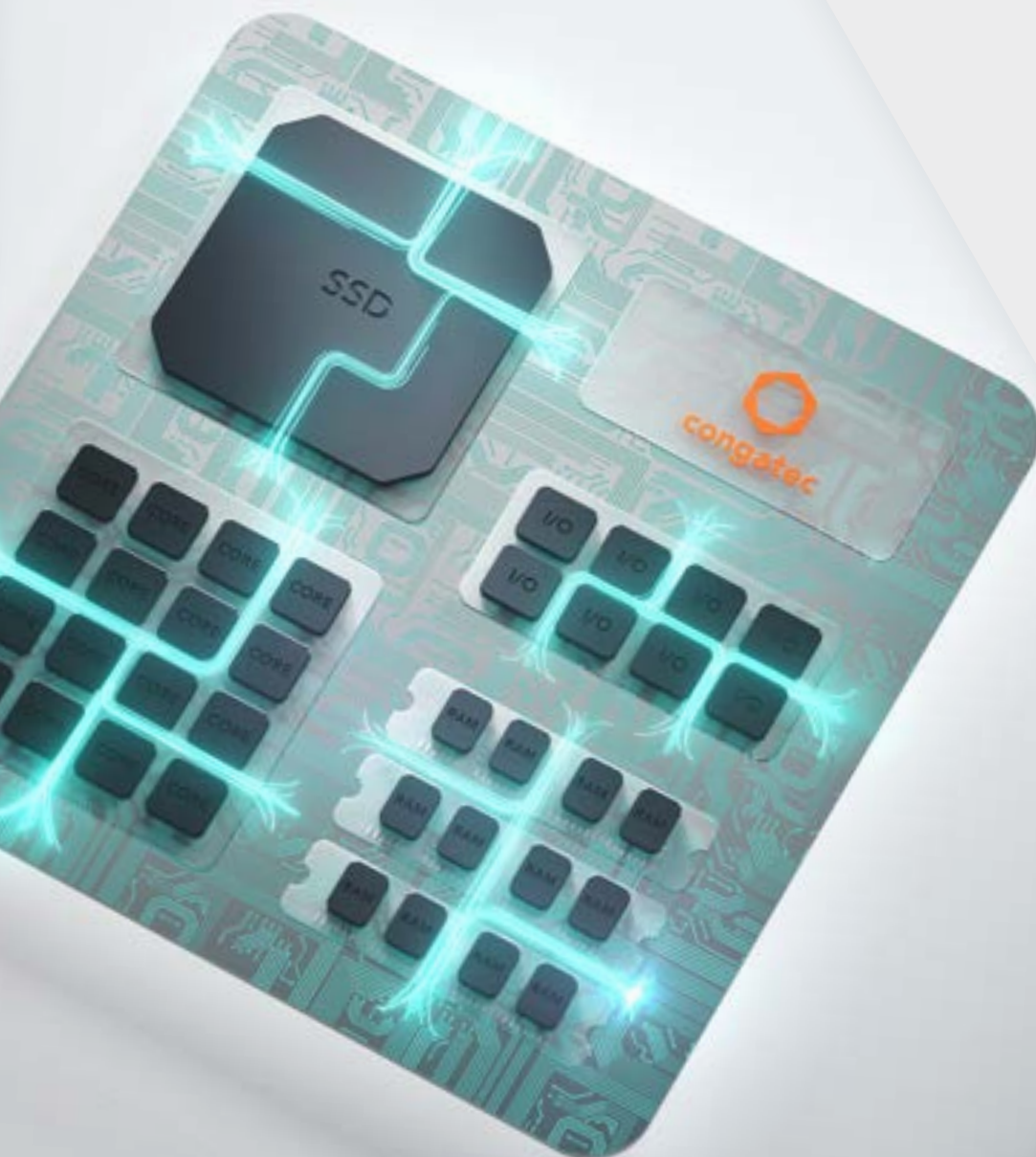


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Introduction

Next-gen systems need to do it all: real-time control, complex computing, ironclad security, and even AI – all while keeping costs down and beating the competition to market. Traditional design approaches are falling short, leading to sprawling, power-hungry systems that are a nightmare to maintain and upgrade.

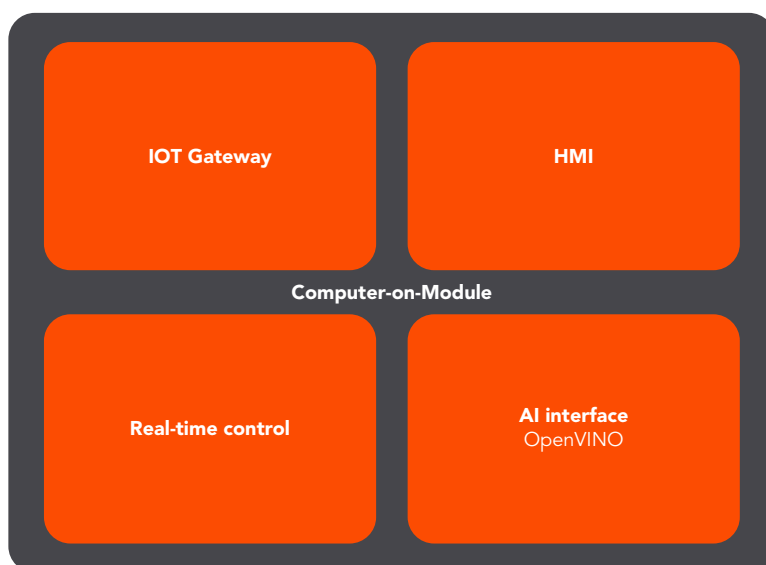
Enter workload consolidation. By harnessing the power of virtualization, it's now possible to run multiple, diverse workloads on a single platform. Workload consolidation not only reduces hardware requirements but also enhances system reliability, efficiency, and scalability.

This white paper explores the transformative potential of workload consolidation, detailing how it enables

companies to streamline operations, lower costs, and accelerate time-to-market. Whether you're looking to optimize your existing infrastructure or planning to deploy cutting-edge technologies like AI and IoT, understanding workload consolidation is key to staying competitive in today's market.

What is workload consolidation?

Instead of relying on several systems operating independently of one another, workload consolidation combines multiple tasks onto a single hardware platform through virtualization. This has several advantages compared to traditional computing.



Workload consolidation helps to reduce the number of systems, improving overall efficiency, cost, energy consumption and reliability.

First, because you only have to maintain a single system, you're looking at reduced hardware requirements, cabling, and complexity. Fewer systems also means fewer points of failure. So not only are you looking at a lower upfront investment but also more reliable hardware, resulting in improved mean time between failures and lower maintenance costs.

Workload consolidation also enhances overall system efficiency. It ensures you utilize all available resources by running multiple operating systems and that cores are not left idle. This in turn allows you to optimize both performance per watt and battery runtime.

But it is also possible to start from the other direction. With system consolidation OEMs can separate their monolithic software into dedicated function blocks hosted on different virtual machines but running still on one single hardware platform. The beauty of software this function separation is, that smaller function blocks

are easier to upgrade and update which streamlines development, certification, and roll-out, as well — all without affecting the complete application. Combined with separation of applications into modular workloads, consolidation also enhances agility. Combined with reduced hardware complexity, this reduced software complexity can improve your time-to-market, conferring an important competitive advantage.

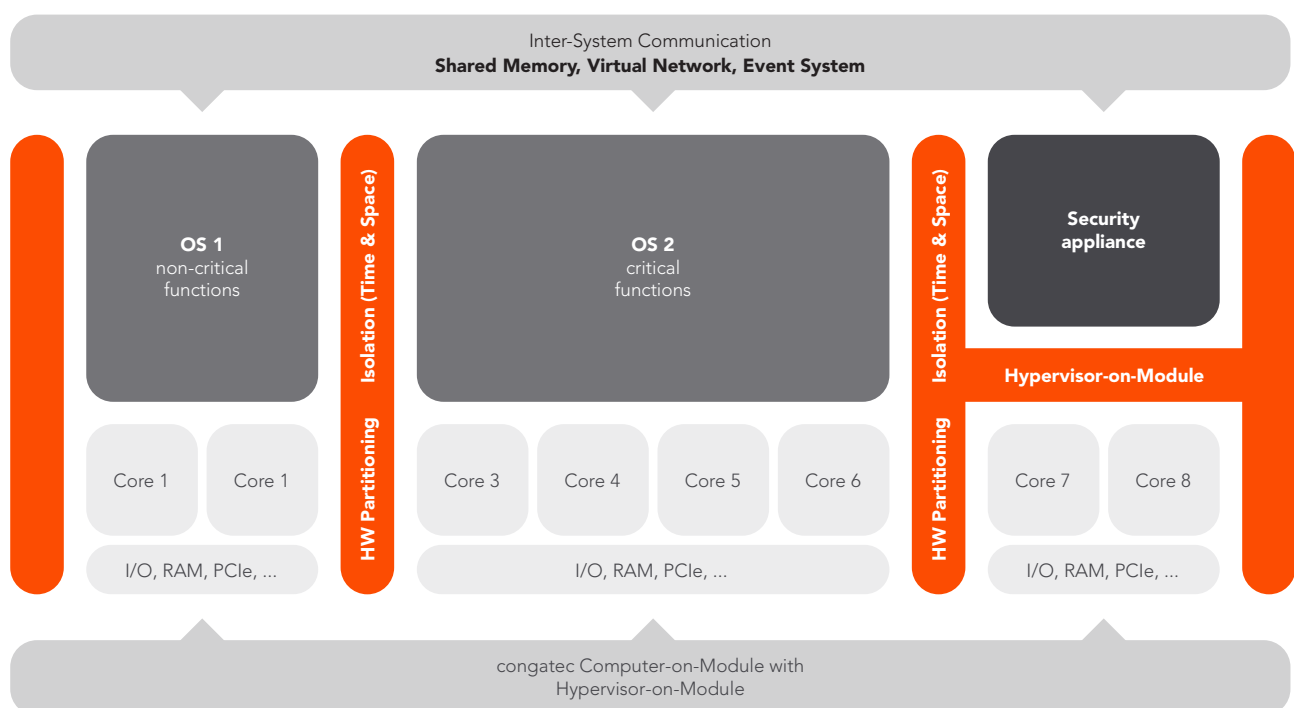
Finally, consolidation helps future-proof your systems. Instead of having to completely rebuild your hardware platform, it allows you to add leading-edge functionalities such as AI or secure IoT connectivity simply by installing another virtual machine. The hardware platform remains unchanged.

To understand the full scope of how workload consolidation provides all these benefits, it's important to learn a bit more about virtualization and hypervisors.

What is virtualization?

In this context, virtualization creates a hardware-agnostic virtual representation of a computing environment known as a virtual machine (VM). Each VM functions independently, with its own operating system, resources, and applications. Multiple VMs can be run on a single

physical machine, making it an efficient way to divide and leverage the system's components, including CPU cores, graphics, memory, timers, and I/O devices such as PCIe and USB.

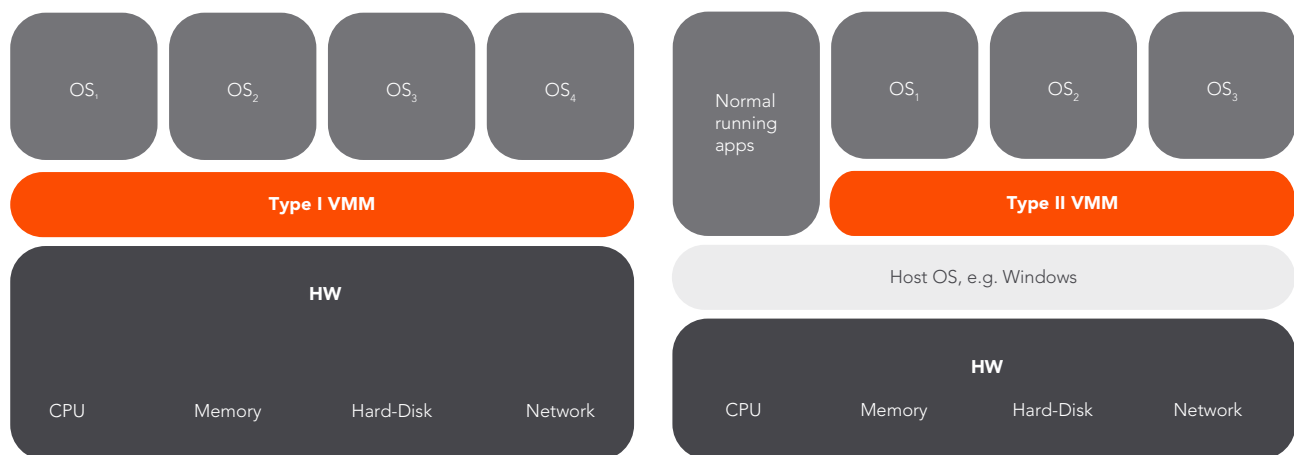


Hypervisor Block Diagram (congatec)

What is a hypervisor?

Also known as a virtual machine manager, a hypervisor creates and manages VMs. It partitions the available resources on a system to enable sharing between VMs and facilitate more efficient workload management. The hypervisor enables communication and coordination between VMs while also isolating them from one another to ensure they do not compromise each other's operations.

There are two types of hypervisors



Type 1 Hypervisors run directly on a system's hardware. Also known as bare-metal hypervisors, they are frequently used to maintain virtual servers and support real-time computing. Examples include VMware ESXi, Microsoft Hyper-V, and the real-time Hypervisor from Congatec.

Type 2 Hypervisors run on a host operating system. They are commonly used in IT and other business environments. Examples include Oracle VirtualBox, VMware, and VMware Workstation.

How congatec streamlines system consolidation



Security

Independent and hardware-assisted protection (OS and BIOS operation).



Harness the power of each core on multicore processors.

Supported operating systems

The RTS Hypervisor enables a combination of Real-Time and General-Purpose Operating Systems (RTOS/GPOS).



+ 0.00 μ s latency

Maintain hard real-time and determinism in high-performance control systems via temporal workload isolation.



Virtualization²

Deploy containers and self-defined virtual machines on top of the RTS hypervisor using Nested Virtualization.

Runs on all

x86 processors

(Intel and AMD) and scales from Multi-Socket Servers to Low-Power mobile devices.



From x to 1 - System consolidation

Transition to a consolidated, single-system architecture to cut costs, enhance agility, and expedite time to market.

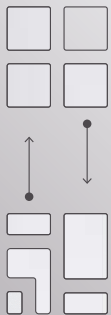
32.4%

CAGR from 2023-2028 for Software Defined Everything (SDX) growth. Leverage this megatrend with hardware virtualization.

RTS Hypervisor

Extend functionality

Add IoT, predictive maintenance, security, and AI vision using virtual machines.

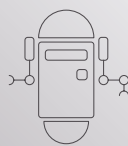


Harness the power of today's multi-core processors. This powerful real-time hypervisor is proven in more than 100,000 systems worldwide.

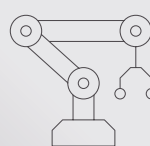
Applications



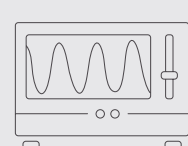
Medical technology



Robotics



Industrial automation

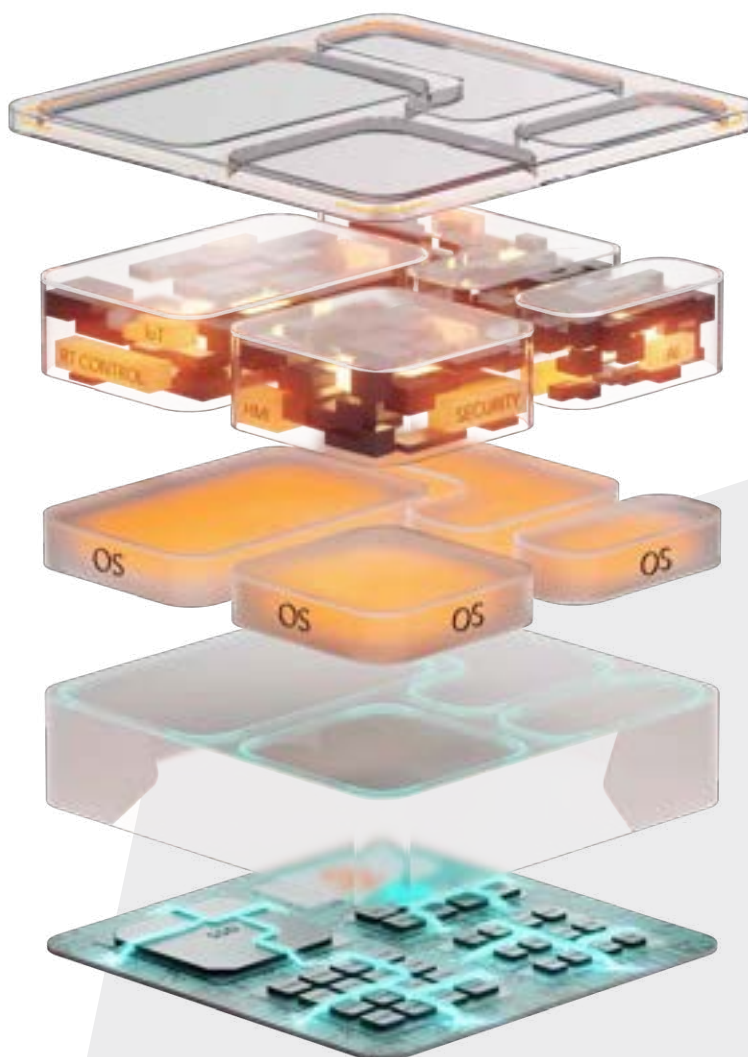


Test & measurement systems

congatec implements the industry-leading hypervisor on its “Virtualization Ready” Computer-on-Module as firmware feature called Hypervisor-on-Module. This innovative feature makes congatec an innovator for system consolidation by virtualized solutions. To that end, the company initiated aReady.COM. Short for application-Ready Computer-On-Modules, aReady.COM is supported by aReady.VT, which allows the system to consolidate functionality that previously required multiple dedicated systems onto a single platform.

aReady.COMs feature a freely configurable set of software layers on top of a high-performance COM based on open standards which can be combined with a custom carrier board to achieve both rapid time-to-market and design optimization. Customers can freely configure the following software functions:

- ▶ The bespoke “Hypervisor-on-Module” firmware feature which enables to run the hypervisor directly on the module with pre-configured VMs, if required..
- ▶ Preinstalled, preconfigured, and fully licensed operating systems. Possible combinations can include real-time Linux, Ubuntu and/or ctrlX OS from Bosch Rexroth.
- ▶ IoT-software building blocks and more.



aReady.COM offer a freely configurable and application-ready set of hardware and software building blocks including the COM, cooling, hypervisor, OSes including Ubuntu Pro and ctrlX OS as well as functional software like aReady.IOT.

What can aReady.COM do?

With aReady.COM, developers can use a single performance-efficient embedded hardware platform to support a wide range of different use cases, including, but not limited to:

Deterministic automation and control

These systems provide predictable and precise timing in industrial and manufacturing processes. Deterministic workloads are increasingly networked and require cross-network synchronization via a networking stack like Time-Sensitive Networking (TSN). Deterministic systems also frequently interact with other non-deterministic workloads. For example, a system might need to run deterministic workloads such as motion control and TSN alongside predictive maintenance algorithms.

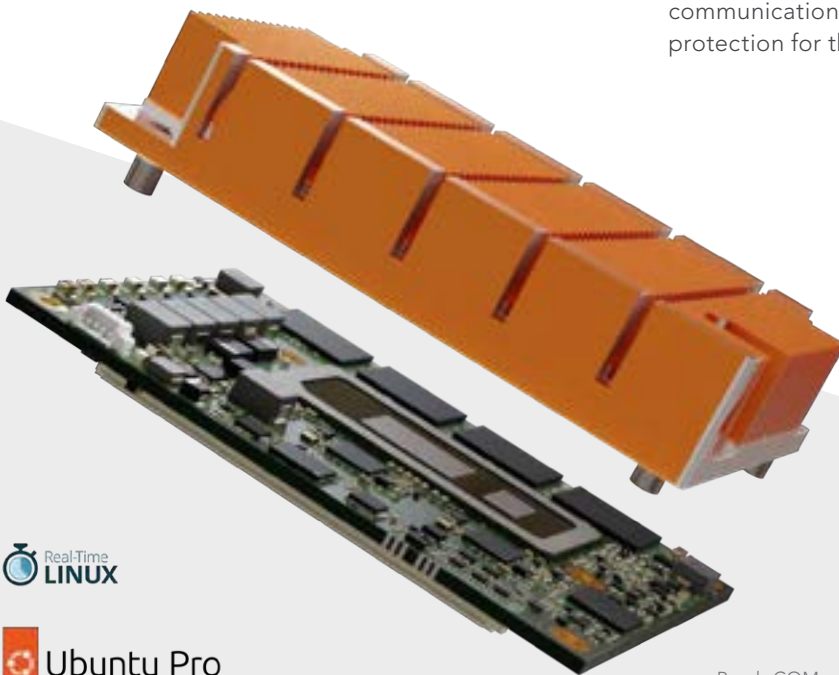
aReady.COM provides a straightforward means of implementing both types of workloads onto the same hardware.

High-Performance heterogeneous compute

Sophisticated and demanding workloads often require a combination of processors and computing units to optimize their performance on various tasks. aReady.COM provides a solid foundation for these applications with multi-architecture System-on-Chips (SoCs) that incorporate CPUs, AI accelerators, and GPUs.

Security via IEC 62443

An international series of standards for Industrial Control System (ICS) security, IEC 62443 is increasingly crucial in the current cybersecurity climate. aReady.COM makes it easier to meet IEC 62443 standards by isolating different workloads. It also offers features such as secure boot, isolated security domains, and encrypted communication, helping to provide comprehensive protection for the entire edge computing stack.



aReady.COMs can be freely configured with hypervisor, and operating systems. A powerful cooling solution is also included (congatec)

AI & Machine Learning

Predictive maintenance is just one example of the many types of AI and Machine Learning (ML) capabilities being deployed at the edge. Other use cases include real-time object detection and classification in manufacturing, natural language interfaces for human-machine interaction, medical imaging, precision farming, and advanced driver assistance.

Ubuntu Pro is a natural home for these sophisticated workloads, with a robust ecosystem for applications such as You Only Look Once (YOLO) for machine vision applications and Hugging Face for ML and Natural Language Processing (NLP). With aReady.COM, developers can seamlessly integrate these applications with control and automation functions. This, in turn, unlocks critical efficiencies that could prove key to remaining competitive in highly demanding markets.

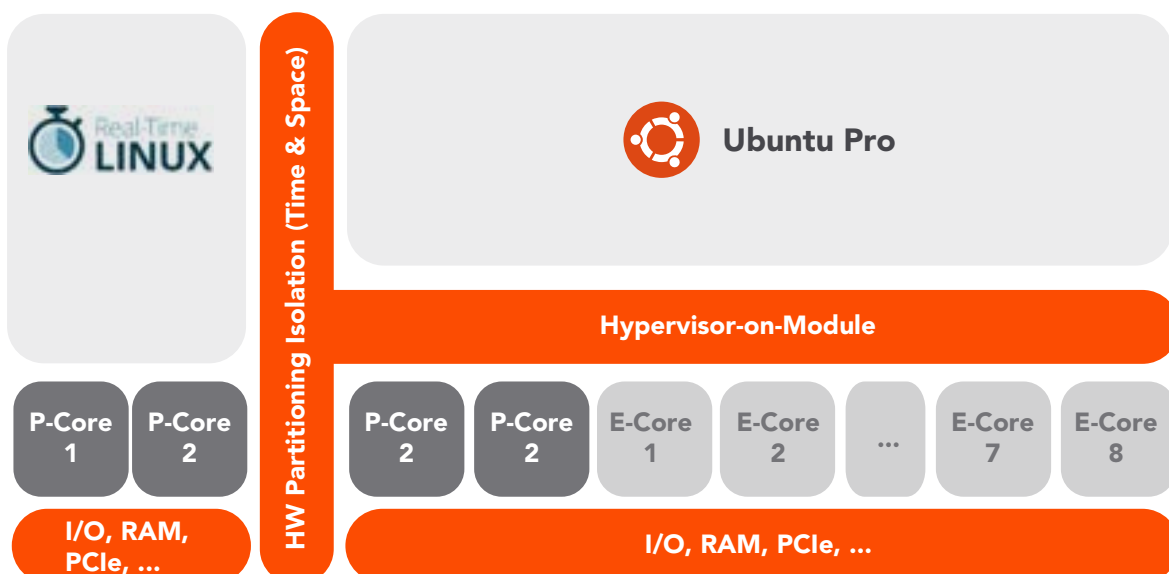
Simplify your design from COM to cloud

Today's technology landscape moves and evolves at breakneck speed. Keeping up requires a new approach to system design. Workload consolidation embodies that approach, reducing cost, complexity, and time-to-market while increasing system reliability.

congatec's aReady.COMs make it easy to embrace workload consolidation. enhance both agility and responsiveness through pre-evaluated software building blocks, preinstalled and preconfigured operating systems, powerful firmware-based virtualization, and hardware built on open standards. Moreover, through aReady.VT, developers can unlock the full potential of today's multicore processors, supporting advanced workloads from the data center to the edge.

[Visit aReady.COM to learn more](#)

conga-aCOM/cRLP | System Consildation



About congatec

congatec is a leading global provider of high-performance hardware and software building blocks for embedded and edge computing solutions based on Computer-on-Modules (COMs). These advanced computer modules drive systems and devices across industries such as industrial automation, medical technology, robotics, telecommunications, and more. congatec's high-performance aReady. ecosystems simplify and accelerate the solution development, from COM to cloud. This application-ready approach combines COMs with services and customizable technologies that enable cutting-edge advancements in system consolidation, IoT, security, and artificial intelligence. Supported by its majority shareholder, DBAG Fund VIII – a German mid-market fund focused on driving growth for industrial enterprises – congatec has the financial backing and M&A expertise to capitalize on expanding market opportunities.

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