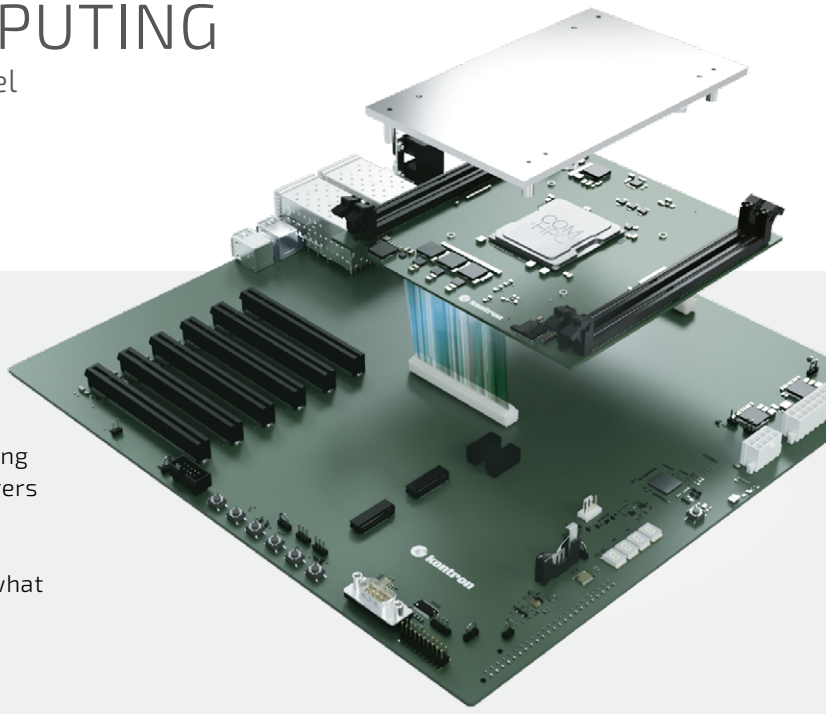
WHITE PAPER
COM-HPC

COM-HPC®

COMPUTER-ON-MODULE FOR HIGH PERFORMANCE COMPUTING

Taking standardized COMs to the next level



The long-established COM Express® standard for Computer-on-Modules (COM) has recently been joined by COM-HPC®, a new High Performance Computing standard from the PCI Industrial Computer Manufacturers Group (PICMG®).

What is the motivation behind this new standard and what does it mean for the widely adopted COM Express®?

CONTENTS

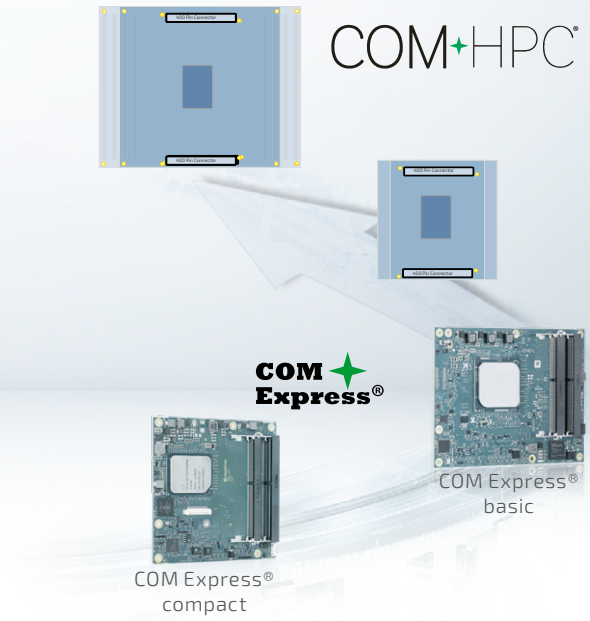
EXECUTIVE SUMMARY

Enabling more powerful and sophisticated embedded servers and client devices for High Performance Computing (HPC) applications is a constant challenge for the embedded computing industry. In 2017 this led the PCI Industrial Computer Manufacturers Group (PICMG®) to introduce its COM Express® Type 7 standard. Kontron was fast to market with its first COM Express® Type 7 multicore processor embedded solutions, supporting powerful data analysis and real-time processing for edge server platforms.

However, the embedded computing industry must always be ready to anticipate and respond quickly to the challenges of future technologies and applications. These are being driven by the Internet of Things (IoT), some of which are already starting to make an impact: Artificial Intelligence/ Machine Learning/Deep Learning and the arrival of autonomous driving and 5G wireless will create enormous data volumes requiring unprecedented computing power and greater connectivity. Totally new design concepts for embedded computers are urgently required as existing standards will no longer be sufficient to cope. These must withstand harsh environments, offer cooling solutions suitable for the embedded industry, enable individual system solutions, and bring all the benefits and advantages of a COM standard to the market.

In response to these growing high performance computing requirements and ensure the COM standard remains fit-for-purpose long into the future, a new working group was set up in 2019 as part of the PICMG standardization committee. This has led to the development of a new highly specific High Performance Computing standard: Computer-On-Modules High Performance Computing (COM-HPC®). The physical footprints and the pinout were agreed by the PICMG working group from the outset, therefore allowing all companies involved in the definition of the specification to be able to bring their first products to market as soon as possible following the standard's official ratification - released in February 2021. While complementary to COM Express®, this initiative takes the proven concept of standardized COMs to a whole new level.

With its first COM-HPC® module and carrier board solutions becoming available in 2021, this whitepaper considers the work that Kontron and other leading manufacturers have undertaken to deliver the new COM-HPC® standard. In addition, it overviews Kontron's initial COM-HPC® products while also assessing the future implications for the COM Express® standard and COM Express® Type 7 for which Kontron remains a major influencer and supporter.



COM Express®: FROM STRENGTH TO STRENGTH

The many advantages of adopting COMs for building embedded applications are widely understood and accepted by system developers. Compared to full custom designs, they can offer a faster, more flexible and scalable approach. COMs can be deployed as quickly as off-the-shelf motherboards and have the benefit of making future processor upgrades much easier.

The industry demand for COMs has therefore risen dramatically over the last 20 years. This has been mainly driven and dominated by the success of standardized COMs due to the industry's ongoing initiatives to ensure the availability of standardized modules. These have provided designers with the peace of mind of clear technology roadmaps, long-term availability of modules in specific format factor sizes, and wide-ranging accessories. Furthermore, standardized COMs from multiple vendors has eliminated reliance on single vendors which has stimulated healthy market competition and pricing.

Over the years, COM Express® has become popular for use in many kinds of embedded computing applications, such as those found in the Industrial Automation, Medical, Defense and Transportation sectors.

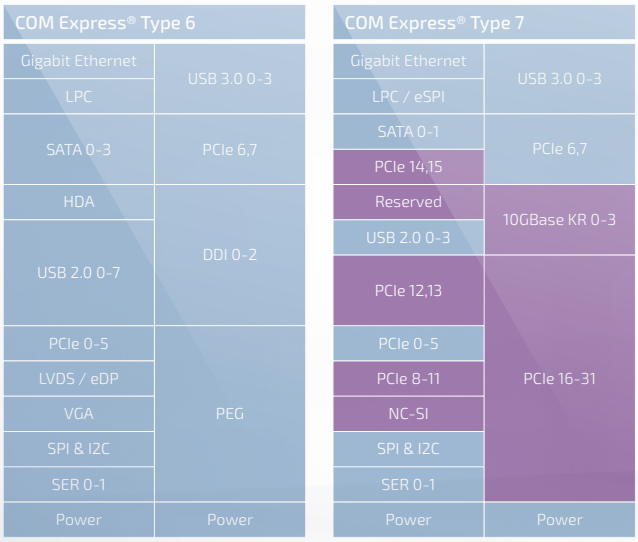
Today, the standard includes the Mini (84 x 55 mm), Compact (95 x 95 mm) and Basic (125 x 95 mm) form factors with Types 6, 7 and 10 pinouts.

COM Express® Type 6 continues to address many embedded client needs by offering a broad range of I/O interfaces for graphics, Digital Display Interfaces (DisplayPort, HDMI, LVDS or eDP) and super-fast USB 3.1. It is therefore equipped to serve many different kinds of application requirements across various market segments. This has been helped by embedded solutions manufacturers offering essential applications pre-integrated on carrier boards as well as custom interfaces. All necessary functionality is therefore easily available at single board level. COM Express® Type 6 also offers wide scalability with compact and basic size form factors and proven ability to use processors with a TDP (thermal design power) of 50 watts or more.

In addition, following its introduction four years ago in revision 3.0 of the COM Express® specification, COM Express® Type 7 has been increasingly deployed by developers - in the rapidly emerging market for IoT high performance edge servers.

COM Express® TYPE 7: ENABLING IoT HPC EDGE SERVER ENVIRONMENTS

Type 7, derived from Type 6 and therefore complementary, offers unprecedented scalability, performance and connectivity all on one platform. The Type 6 pinout was partially modified with the deletion of all audio and graphics interfaces since these are largely superfluous in edge-based IoT environments; retaining only four of the eight USB 2.0 ports; keeping just two instead of all four SATA ports. Therefore, by replacing graphics support with multiple 10GbE-KR ports and defining 32 PCIe lanes, Type 7 is intended for the design of server-grade HPC platforms used for applications requesting high data and network throughput.



WHY COM-HPC®?

The impact of the IoT is rapidly taking embedded computing to a whole new level. In Industrial Automation, for example, exponential amounts of data are being produced from sensors, devices and actuators, often requiring local pre-processing at the edge. Similarly, in the Communications sector the advent of 5G wireless will increasingly generate huge data backhaul traffic volumes and processing requirements. At the same time, autonomous vehicles, factory floor and HPC workloads will demand server-class processors for supporting much higher-end platforms.

Many of these scenarios no longer take place in a protected high-performance computing data center or in the cloud, but close to where the data originates: on mobile masts, on production lines, in warehouses, at processing plants or in autonomous vehicles. I/O data throughput and communications performance is also growing significantly. Consider for example, the quantum leap from the original Gb/s speeds achieved by PCIe in 2003 to the current 32 GB/s of the latest PCIe Gen 5; the arrival of 100 Gigabit Ethernet and USB 4.0; and the ability of remote manageability right down to embedded units.

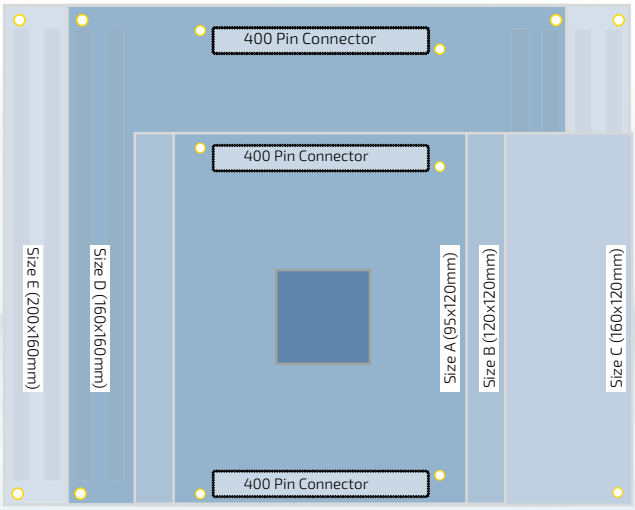
Therefore, developers will soon require standardized high performance COMs which go beyond the limits and capabilities of COM Express® and other COM standards. A new standard has become necessary which although complementary is also distinct from COM Express®. It directly addresses the new demands and supports the need for future-proofed compute, scalability, transmission, and network performance.

HPC DESIGN REQUIREMENTS:

- Data analysis and real-time processing on a single platform
- High scalability
- Faster networking capabilities
- Powerful multicore processing
- Reliability, availability, manageability
- Robust design for harsh environments
- Provide security of IoT edge software applications
- Long term availability – secured upgrade path
- Flexible carrier format - tailored to challenging individual requirements

COM-HPC®: FOR HIGH-END EMBEDDED HPC APPLICATIONS

The new COM-HPC® standard will provide five form factor modules designated A, B, C, D and E.



// Defined Sizes

SUPPORTED INTERFACES		
COM-HPC®/Client		COM-HPC®/Server
A, B, C	SIZE	D, E
48 + 1	PCIe	64 + 1
2	MPI-CSI	-
2	25 GbE KR	8
3	DDI	-
2	SoundWire, I²C	-
2	10GBASE-T	1
4	USB4	2
-	USB 3.2	2
4	USB 2.0	4
2	SATA	2
2	UART	2
1, 2	eSPI, SPI	1, 2
1, 2	SMB / I²C	1, 2
12	GPIO	12

COM-HPC®/Client

Sizes A, B, and C relate to three embedded COM-HPC®/Client modules for use in high-end embedded applications. These will focus on powerful graphics and connect 2x MIPI-CSI (Mobile Industry Processor Interface – Camera Serial Interface) for imaging tasks including those required for medical equipment, autonomous vehicles and surveillance.

COM-HPC®/Client modules are positioned above COM Express® Type 6, for a wide range of embedded applications requiring increased processing and graphics capabilities, faster data transmission and network connectivity.

- Power envelope up to 150 W
- Up to 48 + 1 PCI Express® Gen4/5 lanes
- Up to 4 graphics interfaces
- Up to 2x 25 Gbit Ethernet interfaces
- Module sizes: A: 95 x 120 mm;
  B: 120 x 120 mm;
  C: 160 x 120 mm

COM-HPC®/Server

Sizes D and E are for the two COM-HPC®/Server modules intended mainly for high performance edge server class applications such as AI and analytics, to manage high data volumes involving high speed transmission and real-time processing. They are focused on providing even higher scalability, compute and communications performance than COM Express® Type 7.

- Power envelope up to 300 W
- Up to 64 + 1 PCI Express® Gen 4/5 lanes
- No graphic interfaces
- Up to 8x 25 Gbit Ethernet interfaces enabling 100 Gbit Ethernet
- Module sizes: D: 160 x 160 mm;
  E: 200 x 160 mm

COM-HPC®: KEY HIGHLIGHTS

- COM-HPC® specification allows server and client pinout on all five sizes
- Legacy features have been reduced as much as possible (e.g. no LVDS, no HDA, no VGA, no LPC)
- The significant increase in compute performance will be enabled by the increase in power supported - up to 250-300 W overall power envelope compared to the typically maximum of 80 W of COM Express® - to leverage latest generations of multicore CPUs.
- The boost in transmission and connectivity performance will come from a new module to carrier board connector (high density connector). PCIe Gen4/5 and 10 Gb/25 Gb Ethernet compliant, this will be offered in 5mm and 10mm stack heights and provide 2 x 400 pin out connection rather than the 2x 220 with COM Express® - thereby doubling the total number ofsupported PCIe lanes from 32 (COM Express® Type 7) to 64 for COM-HPC®/Server.

COM-HPC®

- COM-HPC® supports data rates of up to 32 Gbit/s per lane via PCIe (Gen 5) compared to typically 8 Gbit/s with COM Express® today
- For high-end edge server applications, the increase in throughput speeds possible on COM-HPC®/Server modules will substantially increase overall connectivity performance: up to 8x 25 Gb Ethernet lanes and 64 PCIe lanes (Gen 4/5) enabling data transfer rates up to 128 GBytes/s for a x16 link. There will also be 2x USB 4 interfaces which will nearly double the rates of USB 3.2
- COM-HPC®/Server modules support up to 1 TB of RAM using the eight DIMM sockets provided
- For maximum product lifetime, COM-HPC® modules will be easily upgradable and interchangeable as application performance needs change with new technology developments

COM-HPC® - COMPARISON TO COM EXPRESS®

COM-HPC®/Client	COM Express® Type 6	COM-HPC®/Server	COM Express® Type 7
2x 400 pin connector	2x 220 pin connector	2x 400 pin connector	2x 220 pin connector
2x NBase-T (max. 10 GByte)	1x NBase-T (max. 1 GByte)	2x NBase-T (max. 10 GByte)	1x NBase-T (max. 1 GByte)
48x PCIe + 1x PCIe (dedicated for BMC)	24x PCIe	64x PCIe + 1x PCIe (dedicated for BMC)	32x PCIe
2x SATA	4x SATA	2x SATA	2x SATA
4x USB 4.0, 4x USB 2.0	4x USB 3.1, 4x USB 2.0	2x USB 4.0, 2x USB 3.2, 4x USB 2.0	4x USB 3.1
2x 25 GbE KR	LVDS 2x24/eDP/MIPI DSI	8x 25 GbE KR	4x 10GbE KR
3x DDI + 1x eDP/DSI + SoundWire	3x DDI + 1xLVDS or 1x eDP + HDA		
1x IPMI + 1x PCIe (BMC on carrier) for remote management		1x IPMI + 1x PCIe (BMC on carrier) for remote management	1x NSCI for remote management
„Low Speed" (IPMI, eSPI, SPI (BIOS), GPP SPI, SMB, 2x I2C, 2x UART, 12x GPIO, MIPI CSI, MISC)	„Low Speed" (eSPI/LPC, SPI (BIOS), SMB, I2C, HDA, UART, 8x GPIO/SDIO, MISC)	„Low Speed" (IPMB, eSPI, SPI (BIOS), GPP SPI, SMB, 2x I2C, 2x UART, 12x GPIO, MISC)	„Low Speed" (eSPI/LPC, SPI (BIOS), SMB, I2C, UART, 8x GPIO/SDIO, MISC)

COM-HPC®: OUT-OF-BAND MANAGEMENT

COM-HPC® defines Out-Of-Band (OOB) or remote management features that were not addressed by COM-Express®. Briefly introduced in the main COM-HPC® specification document, OOB is covered thoroughly in the PICMG COM-HPC® Platform Management Interface Specification companion document.

The table below shows the total scope of the definition where all combinations between carrier and module are interchangeable. The carrier can be unmanaged or populated with a BMC (Board Management Controller) while the module can either be designed with none, or two levels of management functionality – basic or full. The embedded controller on the module - MMC (Module Management Controller) – has a small footprint with no need for additional adjacent components, enabling a cost-effective and space-saving implementation.

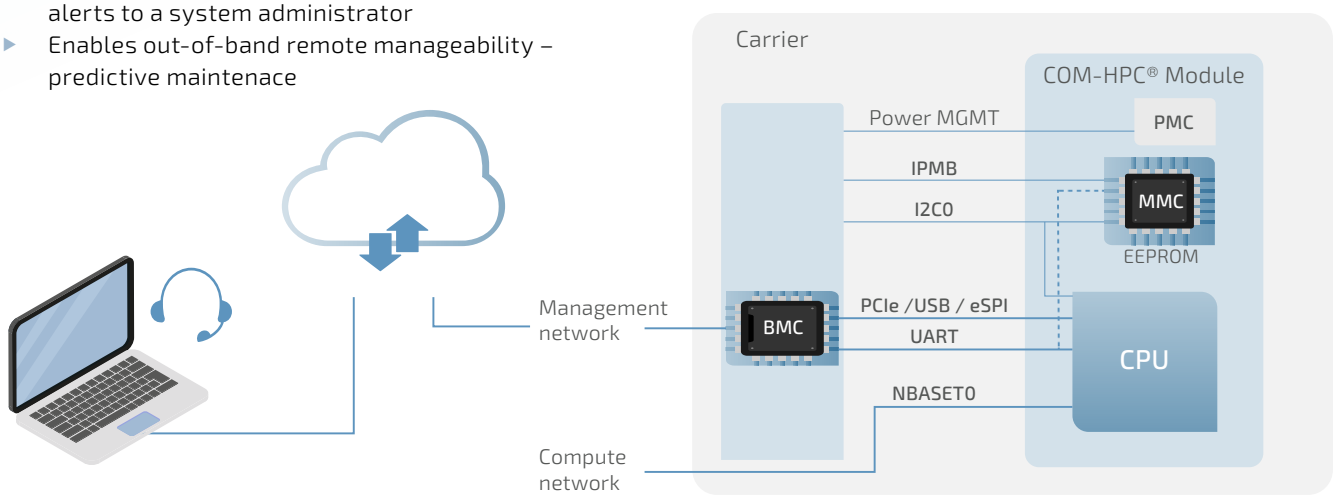
OVERVIEW: COM-HPC® MANAGEMENT SOLUTIONS

	SHORT	DESCRIPTION
Carrier	C.U	- Unmanaged - The carrier has no BMC. Power and chassis management is typically done via microcontroller
	C.M	- Managed via BMC - BMC ca manage every kind of module - Communication between BMC and modue via various interfaces e.g. PCIe, IPMB, USB, LAN
Module	M.U	- Unmanaged (No MMC) - Dedicated EEPROM (EeeP) for module identification
	M.B	- Basic Management capabilities (e.g. via low cost MMC) - Management via external interfaces
	M.F	- Full Management capabilities - Redfish and IMPI via MMC (ETH or IPMB)

The COM-HPC® specification allows the freedom of many different management concepts, however a typical implementation may comprise pairing a managed carrier with a module populated with a MMC with basic management capabilities. The MMC controller supports a subset of the overall IPMI command set to communicate with the BMC on the carrier via IPMB. Using I2C the module's EEPROM can be addressed for module identification; the UART can be used as the serial console between the main module CPU, carrier BMC and module MMC. Interfaces such as PCIe and USB allow the BMC to emulate a KVM interface.

As shown in the graphics below, the remote system management interface enables centralized control and scheduling for predictive maintenance. BMC on carrier and MMC on module enables sensor monitoring/alerting and providing remote manageability.

- Interface to connect a MMC to a BMC
- Monitors the sensors and can send alerts to a system administrator
- Enables out-of-band remote manageability – predictive maintenace



// Typical COM-HPC® Management Solution

COM Express® Type 7

For many years to come, the highly scalable COM Express® Type 7 will continue to be a best-seller, especially when smaller footprint, power savings, and cost are primary factors.

Type 7 offers considerable scope for combining powerful processing with high speed Ethernet connectivity and high data throughput. It has the power and flexibility of multicore parallel processing, 4x 10GBit network interfaces, and multiple PCI Express® lanes. NC-SI sideband signals also provide the ability to perform remote diagnostics and predictive maintenance in combination with a Board Management Controller (BMC) on the baseboard.

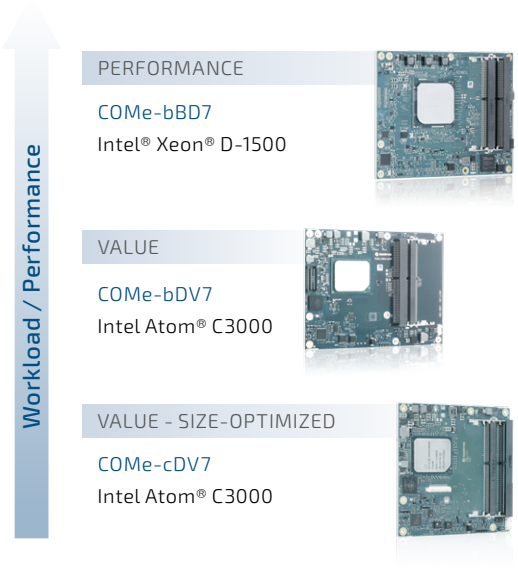
COM Express® Type 7 perfectly addresses a broad spectrum of IIoT applications requirements, including:

- Value-oriented optimized performance/watt implementations with Ethernet connectivity e.g. network routers, gateways, and microservers
- Edge- and Fog-Computing
- High bandwidth mobile communications: at the edge of carrier base stations
- Industrial: machine temperature monitoring; camera inspection; intelligent power control; indoor and outdoor small cell applications




FEATURE	COMe-cDV7	COMe-bDV7	COMe-bBD7	FUTURE COM Express® TYPE 7 MODULE
Positioning	Low power - Value level, space optimized	Low power - Value level	Performance level	Performance level
Memory	Up to 2x 32 GByte DDR4 up to 2400 MT/s - max. 64 GByte	2x 32 GByte DDR4 up to 2400 MT/s - max. 64 GByte 4x 32 GByte DDR4 up to 2133 MT/s - max. 128 GByte	2x 32 GByte DDR4 up to 2400 MT/s - max. 64 GByte	2x 32 GByte DDR4 up to 2933 MT/s - max. 64 GByte 4x 32 GByte DDR4 uo to 2666 MT/s - max. 128 GByte
LAN	1x GbE Base-T Up to 4x 10G-KR	1x GbE Base-T Up to 4x 10G-KR	1x GbE Base-T 2x 10G-KR	1x GbE Base-T 4x 10G-KR
PCIe	Max. 14x PCIe Gen 3.0	Max. 14x PCIe Gen 3.0	32x PCIe lanes 8x PCIe Gen 2.0 24x PCIe Gen 3.0	32x PCIe lanes 16x PCIe Gen 3.0 16x PCIe Gen 4.0
USB	Max. 4x USB 3.0/2.0	Max. 4x USB 3.0/2.0	4x USB 3.0/2.0	4x USB 3.0/2.0
SATA	Max. 2x SATA Gen3	Max. 2x SATA Gen3	2x SATA Gen3	2x SATA Gen3
Onboard storage	eMMC 5.1	eMMC 5.1	SSD via SATA	NVMe via PCIe x1
Ind. Temp. SKUs	Some ind. temp SKUs available	Some ind. temp SKUs available	Some ind. temp SKUs available	Some ind. temp SKUs available

Kontron's powerful COM Express® Type 7 edge HPC server module portfolio (COMe-bBD7, COMe-bDV7 and COMe-cDV7) provides a broad feature variety and high scalability for various workload and performance application requirements:



- 2 to 16 CPU cores with Intel Atom® C3000 or Intel® Xeon® D-1500 processor family
- Max 45 W CPU TDP
- Up to 4x 10Base-KR interfaces
- Up to 128 GByte DDR4 memory
- Extended temperature range variants of -40 °C to 85 °C

Furthermore, the COM Express® Evaluation Carrier T7 Board was developed especially for the Kontron COM Express® Type 7 modules. It comes with an ATX form factor (305 x 244 mm²) and forms a turnkey server development platform together with the module. It supports, for example, 32 PCIe lanes fan out into 7 PCIe slots, 4x USB 3.0, 2x SATA3, 2x RS232, GPIO and various adapter cards to support 4x 10 GbE in different connectivity flavors.

COM-HPC®

COM-HPC® allows developers to keep pace with the ultra-high HPC requirements of the future.
However, as they start becoming available during 2021, COM-HPC® modules will complement rather than compete with COM Express® 7 in the market: Based on the latest generation of server-class processors, COM-HPC® solutions will be aimed at satisfying more power-hungry applications (CPU TDP up to 150 W, overall power envelope up to 250 – 300 W) compared to Type 7. They will also address implementations where more features and functions are required. However, the additional performance and feature-sets will command a higher entry level price.

TYPICAL USE CASES: COM-HPC®

Multiple PCIe lanes combined with High-Speed LAN connectivity and PCIe x16 ports for high performance GPGPUs/FPGAs:
- AI – machine learning + camera inspection
- Test & Measurement
- Autonomous driving & truck fleet control
- Data logger
- Automotive test equipment

High performance multi-core processors and multi-LAN support up to 40Gb/100Gb Ethernet:
- 5G RAN platforms
- Network appliances
- Datacenter switching with high speed uplinks

Processing power combined with High-Speed Ethernet connectivity:
- Surface inspection
- Assembly control
- Pattern recognition

Making the right choice

The introduction of the new COM-HPC® standard allows a new technology approach for many embedded applications, however, it can also create some uncertainty. So, which is the right choice – COM Express® or COM-HPC®?

Always bear in mind that COM Express® and COM-HPC® are complementary standards and clearly differentiated with respect to performance, overall feature sets and price level.

COM Express® is most probably the right platform when:
- The performance level and memory capacity matches the application requirements – processor TDP up to 60 W – memory capacity up to 128 GByte
- A smaller footprint and thermal limit is necessary
- Extending the longevity of an existing COM Express® solution to save investment and ensure continuity
- There's a low to medium budget consideration

COM-HPC® is more likely to come up trumps when:
- Processor power is required beyond 60 W TDP
- Memory capacity must go beyond the limit of 128 GByte
- Faster interfaces such as USB 4.0, PCIe Gen 4/5 or 25Gbit Ethernet (allowing 100GbE interfaces) are required
- To accommodate the above, a larger footprint and price level is accepted

KONTRON COM-HPC® SOLUTIONS

Server Module Type D

The forthcoming Kontron COM-HPC® Server, featuring Nextgen server processor technology, offers wide scalability through the easy connection of additional accelerators including GPGPUs, FPGAs and NVMe-based storage media - or even building a COM-HPC® module farm by connecting multiple COM-HPC® modules.

The larger 160 x 160 mm footprint also allows adequate space for enhanced memory performance: 4x DIMM sockets for up to 512 gigabytes of memory for addressing high memory bandwidth and size requirements of micro and edge servers. An advanced cooling solution with integrated heat pipes for efficient heat dissipation is provided.

A further feature is enhanced I/O performance for carrier board connection: 8x High-speed Ethernet ports for a max of 2x 100Gb Ethernet links (one for failover) and 65 PCIe lanes for PCI Express® Gen 4.0 and Gen 5.0; one lane is reserved for an optional board management controller (BMC) on the carrier; the remaining 64 PCIe lanes are available for connection of peripherals.

- Size D form factor – 160 x 160 mm
- Nextgen high performance processor
- Up to 20 cores, processor TDP up to 120 W
- 32x PCIe Gen 4.0 lanes + 16x PCIe Gen 3.0 lanes
- Up to 8x LAN Ports for various configuration: 100GbE/2x 50GbE/4x 25GbE + 4x 10GbE
- Memory: Max 512 GByte DIMM-DDR4 with 4x DIMMs
- Optional onboard storage NVMe
- Industrial temperature versions
- Embedded management controller

The comparison table below shows the different positioning of module platforms for COM Express® Type 7 and COM-HPC®/ Server in terms of performance, memory capacity and IO connectivity based on real processor technologies.

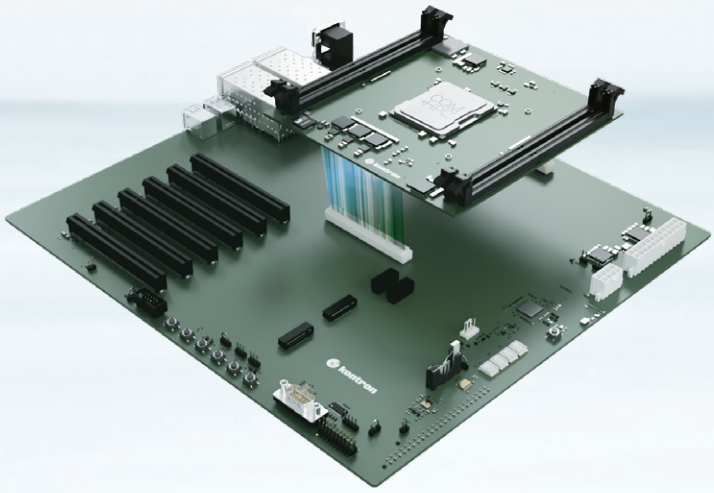
KONTRON'S SOLUTION: COM EXPRESS® TYPE 7 VS COM-HPC®/SERVER

FEATURE	COM Express® TYPE7 BASED ON NEXTGEN MEDIUM SERVER-CLASS CPU	COM-HPC®/SERVER BASED ON NEXTGEN HIGH-END SERVER-CLASS CPU
CPU	Up to 10 Cores	Up to 20 Cores
TDP	Up to 90 W	Up to 150 W
Memory	Max 4x SODIMMs for 128 GByte	4x DIMMs for 512 GByte
LAN	1x GbE Base-T 4x 10GbE	1x GbE Base-T 100GbE/2x 50GbE/4x 25GbE + 4x 10GbE
PCIe	16x PCIe Gen 3.0 16x PCIe Gen 4.0	16x PCIe Gen 3.0 32x PCIe Gen 4.0
USB	Max. 4x USB 3.0/2.0	Max. 4x USB 3.0/2.0
SATA	Max. 2x SATA Gen3	Max. 2x SATA Gen3
Onboard storage	NVMe	NVMe
Ind. Temp. SKUs	Some ind. temp SKUs available	Some ind. temp SKUs available
Form factor	95 x 125 mm	160 x 160 mm
Positioning	Medium performance level	High performance level

KONTRON COM-HPC®/SERVER CARRIER EVALUATION BOARD

An evaluation carrier is essential for ensuring customers quickly become familiar with the new technology and properly assess the COM-HPC® platform as a potential solution for their own system applications.

The Kontron E-ATX compliant evaluation carrier includes all interfaces specified by the new COM-HPC®/Server standard for server modules in sizes D and E. A remarkable level of high-speed connectivity is possible with Ethernet support for 8x 10/25 GbE ports via retimer support to SFP28 cages; breakout cables enable 100GbE QSFP28 support; high-performance data transmission with support for 64x PCIe lanes via various PCIe slots and M.2 connectors; 4x USB 3.1/0 interfaces. In addition, the new COM-HPC® Carrier Server includes all the necessary interfaces for programming, firmware flashing, and reset. The BMC expansion slot enables remote server module management.



// Kontron COM-HPC®/Server Module and Evaluation Carrier

- Support of overall 64x PCIe lanes + 1x PCIe lane for BMC
- Support of overall 8x 10/25Gb Ethernet ports: 8x 10/25Gb Ethernet via integrated re-timer support to SFP28 cages
- 1x 10/1GBase-T interface, directly from COM-HPC®/Server module with basic EMI/ESD protection in RJ-45 integrated magnetic connector
- 4x USB 3.1/0 Interface, directly from COM-HPC®/Server module with basic EMI/ESD protection
- 2x SATA standard interfaces, directly from COM-HPC®/Server module
- BMC expansion slot
- External fan connector
- BIOS POST Code display in the form of 7-Segment display array
- Pin headers for COM HPC® server specific signals enabling measurement like GPIOs, I2C, SMBus and Feature connector
- External BIOS flash socket
- Mechanical Size 308 x 340 mm

KONTRON: VALUE ADDED

Kontron manufactures and supplies one of the industry's largest globally available ranges of off-the-shelf embedded products including Motherboards, SBCs, and COMs. These are designed and developed in response to market and technological developments as well as direct feedback from OEM partners. As testimony to the quality and high performance of Kontron's range of COM and board level products many of these are frequently specified in the company's own range of OEM-category Systems.

All standard and customized products are backed by the company's global services and support network. This includes technical support and product training as well as the benefit of extended product lifecycle management for ensuring product longevity – Kontron's priority access to the latest processor and embedded component technology from the world's major manufacturers is a major advantage to customers when it comes to optimizing product investment. Customers are also able to take advantage of the company's portfolio of middleware and software services when designing and launching IoT solutions.

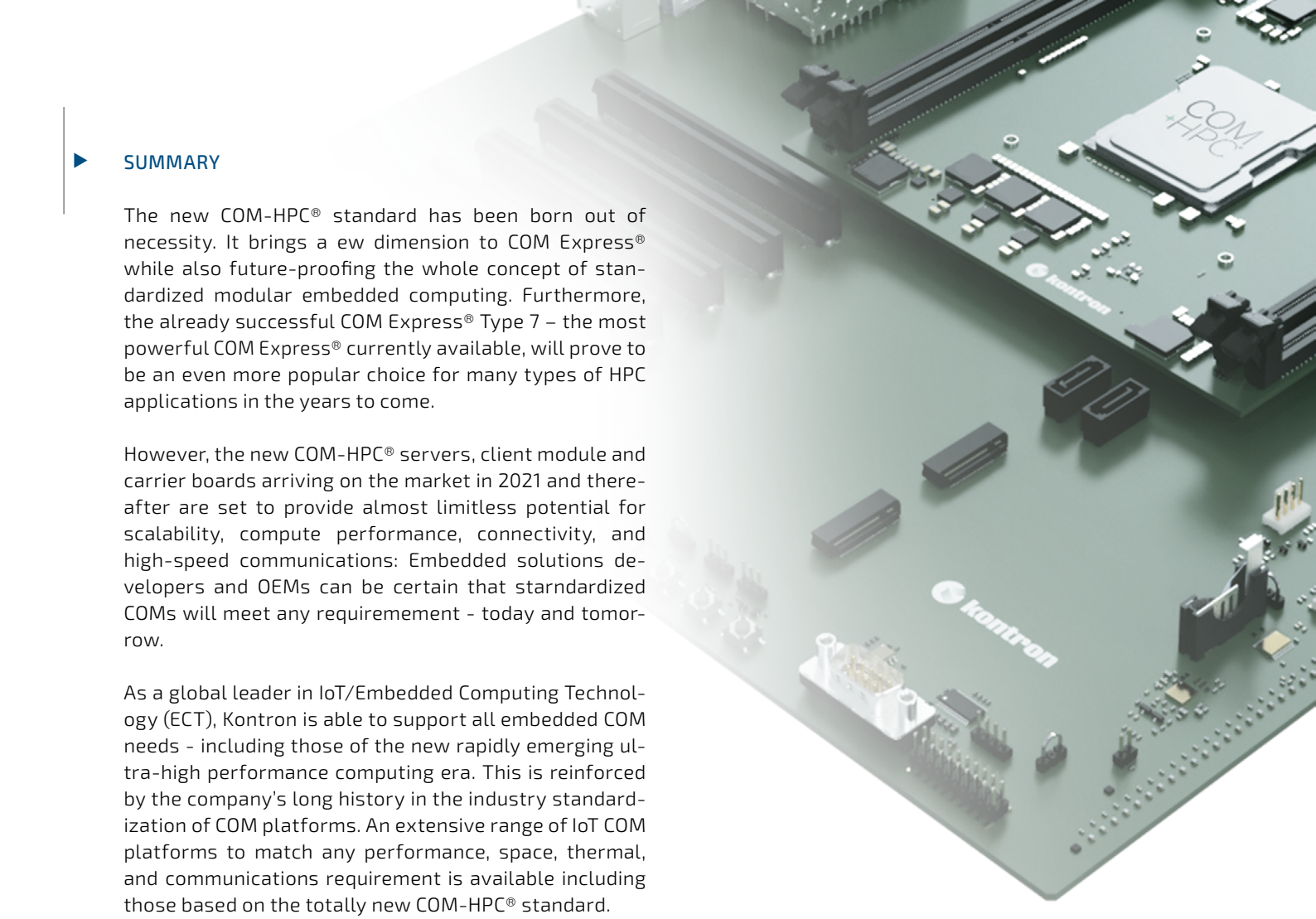
In addition, Kontron can offer all customers - developers, System Integrator and OEMs - comprehensive value added services. These include the provision of full Design-in Services as well as Custom Carrier Boards for facilitating the implementation of part or fully customized embedded modules for specific applications. The company's design excellence results from over 35 years of embedded computing experience. Extensive simulations, product validation and release tests guarantee product reliability under all operating conditions. In production, stringent quality assurance is undertaken using state-of-art manufacturing facilities and well-proven test strategies.

SUMMARY

The new COM-HPC® standard has been born out of necessity. It brings a ew dimension to COM Express® while also future-proofing the whole concept of standardized modular embedded computing. Furthermore, the already successful COM Express® Type 7 – the most powerful COM Express® currently available, will prove to be an even more popular choice for many types of HPC applications in the years to come.

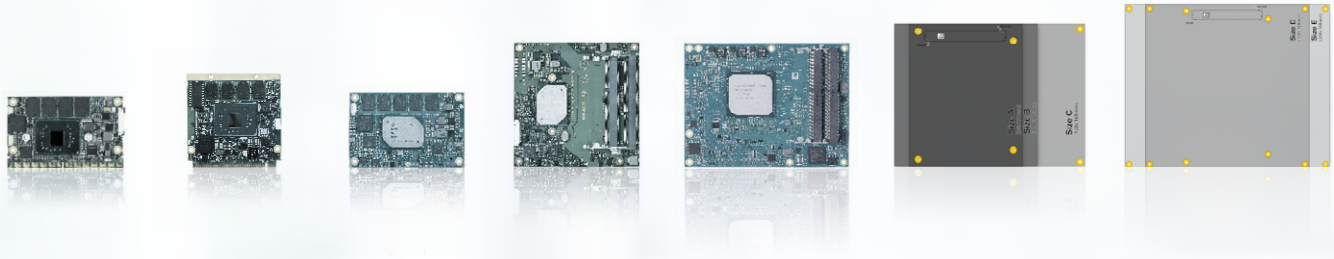
However, the new COM-HPC® servers, client module and carrier boards arriving on the market in 2021 and thereafter are set to provide almost limitless potential for scalability, compute performance, connectivity, and high-speed communications: Embedded solutions developers and OEMs can be certain that starndardized COMs will meet any requiremement - today and tomorrow.

As a global leader in IoT/Embedded Computing Technology (ECT), Kontron is able to support all embedded COM needs - including those of the new rapidly emerging ultra-high performance computing era. This is reinforced by the company's long history in the industry standardization of COM platforms. An extensive range of IoT COM platforms to match any performance, space, thermal, and communications requirement is available including those based on the totally new COM-HPC® standard.



INNOVATIVE IOT PLATFORMS TO MATCH DIFFERENT PERFORMANCE, SPACE & THERMAL REQUIREMENTS

UP TO 15 W	UP TO 35 W	UP TO 80 W	UP TO 120-150 W	UP TO 250-300 W
SMARC module, qseven, COM Express®	COM Express®	COM Express®	COM-HPC®	COM-HPC®



For more information about Kontron COM-HPC® embedded solutions visit
www.kontron.com/products/boards-and-standard-form-factors/com-hpc

About Kontron – Member of the S&T Group

Kontron is a global leader in IoT/Embedded Computing Technology (ECT). As a part of technology group S&T, Kontron offers a combined portfolio of secure hardware, middleware and services for Internet of Things (IoT) and Industry 4.0 applications. With its standard products and tailor-made solutions based on highly reliable state-of-the-art embedded technologies, Kontron provides secure and innovative applications for a variety of industries. As a result, customers benefit from accelerated time-to-market, reduced total cost of ownership, product longevity and the best fully integrated applications overall.

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From modular components to market-ready systems, Intel and the over 1,000 global member companies of the Intel® Partner Alliance provide scalable, interoperable solutions that accelerate deployment of intelligent devices and end-to-end analytics. Close collaboration with Intel and each other enables Alliance members to innovate with the latest IoT technologies, helping developers deliver first-in-market solutions.

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