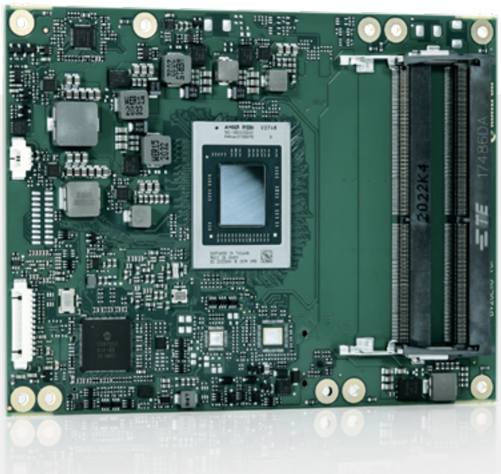
COMPUTER-ON-MODULES FOR MEDICAL DIAGNOSTICS AND SURGERY



Kontron's new COM Express® Computer-on-Modules with AMD Ryzen™ Embedded V2000 processors are literally made for computing applications in medical diagnostics and operating theatres: Next to impressively powerful processor-integrated graphics, they provide massive computing power to run AI algorithms in parallel thanks to their 8 cores and up to 7 AMD Radeon™ compute units. The outcome is optimized imaging for faster medical diagnostics.

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Modern medical diagnostics doesn't rely solely on the human eye, nor does surgery. Instead, computer-assisted systems are increasingly being leveraged to see things that even a trained eye cannot immediately spot. As a result, the market for medical computer vision is expected to grow worldwide at a compound annual growth rate (CAGR) of 23.2 % from € 431.78 million in 2020 to € 1.23 billion by the end of 2025, according to experts at Research and Markets.[1] Emergen Research forecasts even significantly higher growth for the market of AI-based medical imaging solutions such as X-ray, CT or MRI. This market is expected to grow at an annual rate of 31.3 % from € 442 million to € 3.92 billion by 2028.[2]

// Vision systems and AI are innovation drivers for medical devices.

INCREASINGLY POWERFUL IMAGING

The growing demand is driven by a variety of new solutions: Comparatively new, for example, are applications that aggregate 3D information from different sources. Systems that use modern C-arms to generate image data during intraoperative care are an example. This data is then displayed in real time, along with any MRI or CT images generated earlier. Free rotation and zooming in on increasingly complex 3D models without delay are a must for these applications. This requires a considerable amount of computing power. Especially when we're talking about 4k at 60 Hz, i.e. 60 times 4,096x2,160 – i.e. more than 530 million pixels – per second. The same applies to solutions that enable augmented reality. As a result, it becomes for instance possible to project the generated 3D data onto the ongoing surgical procedure in real time, which can yield further significant benefits during surgery.

ARTIFICIAL INTELLIGENCE HAS MANY USES

If Artifical Intelligence (AI) is being used as well, the computing power demands become even more complex. To process deep learning algorithms efficiently, the graphics cores need massive parallel computing power. However, AI is not only used to support medical diagnostics. AI can also be used in imaging procedures to compensate weaknesses of image sensors, for instance to ensure extremely high image quality under difficult lighting conditions and in high dynamic range images – although misleading distortions must of course be ruled out. AI also helps to implement superimposition (normalization) of diagnostic image data from different sources, such as computer tomography, angiography or ultrasound. Another example of the use of AI is stereogrammetry, which generates full-fledged 3D models based on simple X-ray images. Without AI, such models are only obtainable from CT scans.

However, AI is not only interesting for medical imaging. Voice controlling devices in the operating theatre are another use case.[3] Here, AI puts the spoken word into the right context and derives dedicated commands from it. Unlike voice assistants from Amazon, Google or Apple, voice evaluation should be done locally to ensure high reliability, not in the cloud. This requires even higher local computing power, especially if all mentioned functions are to be integrated in one system.

A DIVERSITY OF TASKS

What is more, medical computing systems are not standalone but operate as medical edge computers in a network with the hospital IT, for example to exchange image files via DICOM with the PACS, RIS, and HIS solutions. In addition, they are also increasingly connected within the Medical IoT (MIoT), for example to transmit data to clouds for research and educational purposes, or to enable OEM solutions for remote management, over-the-air updates, or functional enhancements through software upgrades, which all increase the performance and reliability of the devices. The trend towards a subscription economy, in which medical devices are increasingly sold with pay-per-use pricing models or feature-based licensing, poses additional challenges. The systems also need a high level of security, which again requires computing power to safeguard the systems from cyber threats. It's therefore fair to say that medical devices – especially if operated with 4k imaging and integrated AI – represent the absolute high-end in the field of medical computing systems.

// Hospital germs are especially in Covid-19 times a great danger, which is why fanless Medical computing designs are recommended.

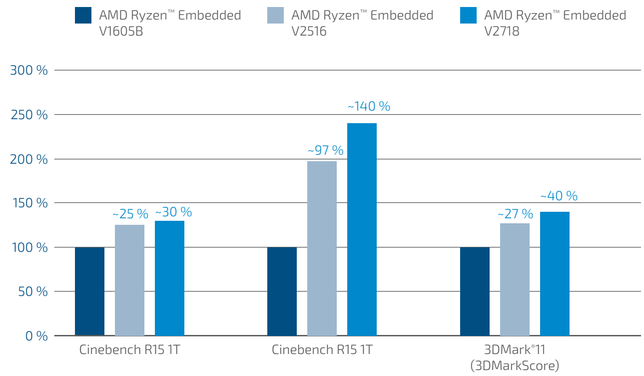
HYGIENE A TOP PRIORITY

Regardless of all these requirements, it's simply not practicable to put a 19-inch rack full of servers requiring hundreds of watts of power and active cooling into an operating theatre. What's needed instead are flexible medical computing designs that can be mounted on mobile carts or hang from the ceiling above the operating table so that they can be used in intensive care units as well as in operating and emergency rooms. A compact and, above all, hygienic and therefore fanless design is a basic requirement for this. Only completely sealed systems can minimize the accumulation and spread of pathogens. Computers that need an active fan to dissipate heat should therefore be avoided. This is because dust accumulates in the housings and vents, where it can form an ideal biotope for germs, which can spread out into the environment with the induced air flow. They are also much more difficult to disinfect, which is another increasingly important reason to opt for energy efficient fanless designs.

EXTREMELY POWERFUL YET EFFICIENT

Processor efficiency is key whenever high-performance is to be integrated into a hygienic design. The new AMD Ryzen™ Embedded V2000 processors set a new milestone for ultra-efficient graphics-rich systems with passive cooling. Thanks to the 'Zen 2' cores and processor-integrated AMD Radeon™ high-performance graphics, they provide not just more computing power but also further significant increases in energy efficiency per watt. This puts them clearly above the already very powerful AMD Ryzen™ V1000 processor generation, which yielded superior performance values in Kontron's own benchmarks.

Compared to the V1000 processors, the new AMD Ryzen™ Embedded V2000 processors – which AMD pledges to support for at least 10 years – impress with 8 CPU cores and 16 threads. That is double of what the AMD Ryzen™ V1000 processors offer. Thanks to the new 'Zen 2' processor architecture and the new 7 nm manufacturing process, they achieve 100 % greater multithread performance-per-watt and up to 30 % higher single-thread CPU performance. At the same time, the maximum heat dissipation (TDP) can be freely scaled between 54 watts down to a cool 10 watts, which is crucial for the design of fanless high-performance medical and medical imaging systems.



// The new AMD Ryzen™ Embedded V2000 processors offer another significant increase in performance per watt.

A MAJOR BOOST IN GRAPHICS PERFORMANCE

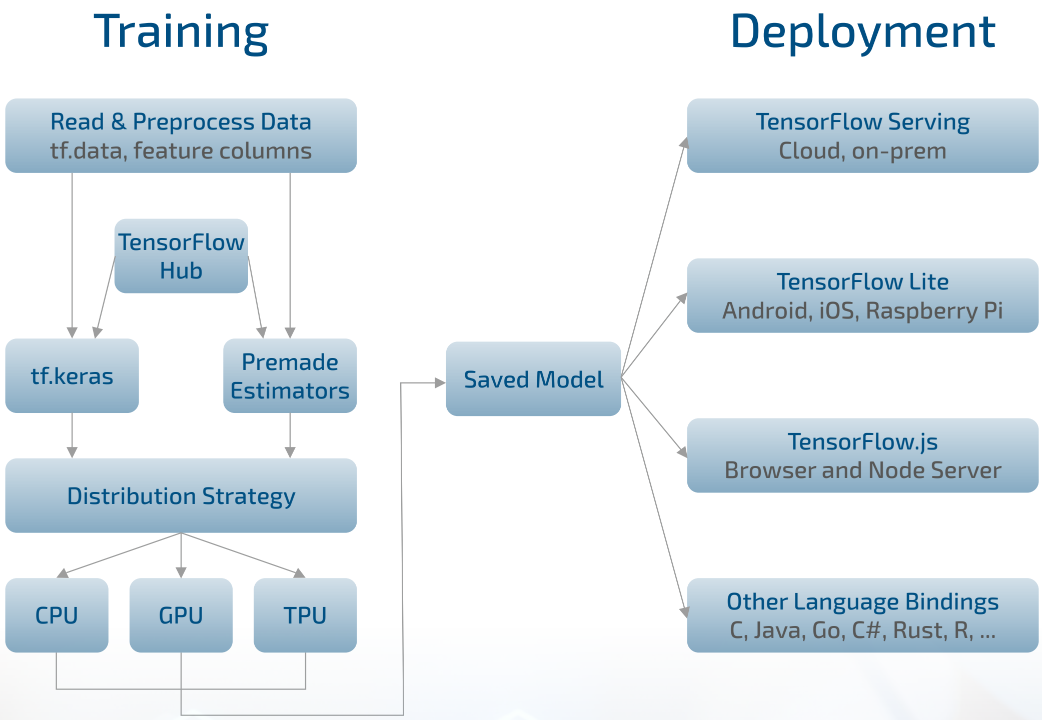
Beyond a significant performance gain in CPU-based computing power, the new AMD Ryzen® Embedded V2000 processors also offer an impressive 40 % increase in graphics performance. The integrated AMD Radeon™ RX Vega graphics card provides up to 7 GPU processing units built on the GCN architecture, which is also very successful in the consumer segment. Manufactured in the currently smallest structure size of 7 nm for x86 embedded processors, it also offers higher energy efficiency and a 300 MHz faster clock speed of now 1.6 GHz. In addition,

// 4k image data provide sufficient detail even for robot-assisted microsurgical tasks.

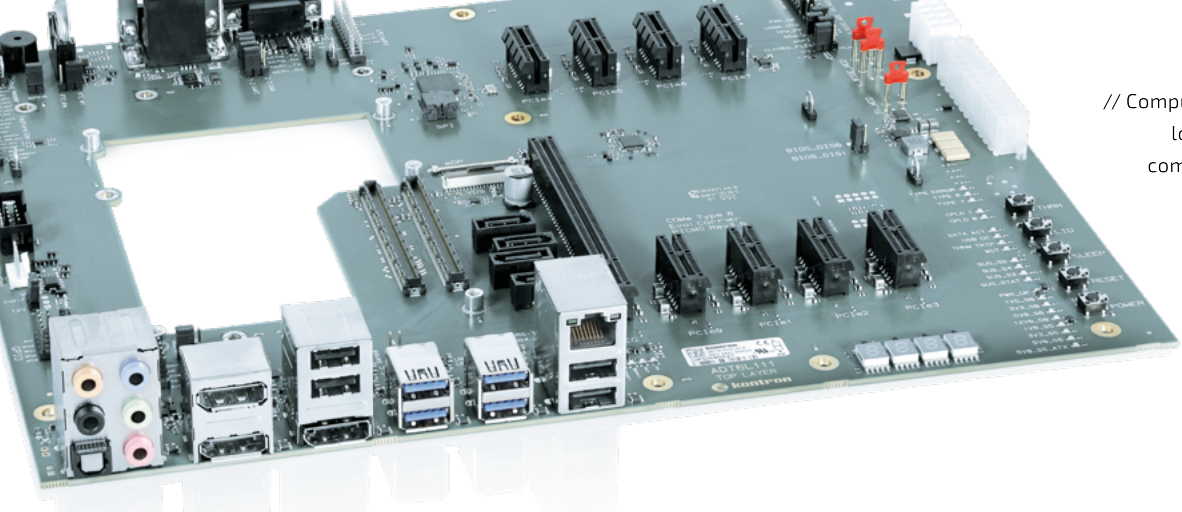
the Vega graphics card supports up to 4 independent 4k monitors, which is an important feature for the highest-quality multi-display installations in operating theatres, for example. Lastly, it is also possible to encode and decode 4k video streams in real-time using the latest high-efficiency video codecs on a hardware basis. This can be useful to distribute, store, and play back 4D sonography or endoscopy recordings in real time via the Ethernet without exceeding the bandwidth limit.

SUPPORT FOR DEEP LEARNING AND AI ALGORITHMS

Of course, the GPU's high graphics performance of up to 1.43 TFLOPS can also be used for AI and deep learning applications. As a matter of fact, a comprehensive open source ecosystem with numerous tools and frameworks is already available for this. These include such basic functions as ROCm for using the graphics units as GPGPU. But there are also powerful open source deep learning frameworks like Caffe and TensorFlow. TensorFlow even runs on Windows 10. Since the end of 2020, the source code of TensorFlow-DirectML has been available as an open source project on GitHub.[4] Also, there are first Windows solutions for Caffe.[5] Developers benefit from consistent open source AI designs for all common operating systems, which provide vendor independence and also underline the general trend towards open source, long-term and secure solutions – especially since this also means significantly higher protection against backdoors.



// ROCm and TensorFlow provide an end-to-end open source machine learning (ML) platform for AMD processor technology. It includes a flexible ecosystem of tools, libraries, and community resources that enable researchers to advance the state of the art in ML and make it easy for developers to build and deploy ML-based applications.



// Computer-on-Modules guarantee the long-term availability of medical computer technology and make the performance scalable.

MODULES – THE PERFECT CHOICE TO INTEGRATE PROCESSORS INTO MEDICAL DEVICES

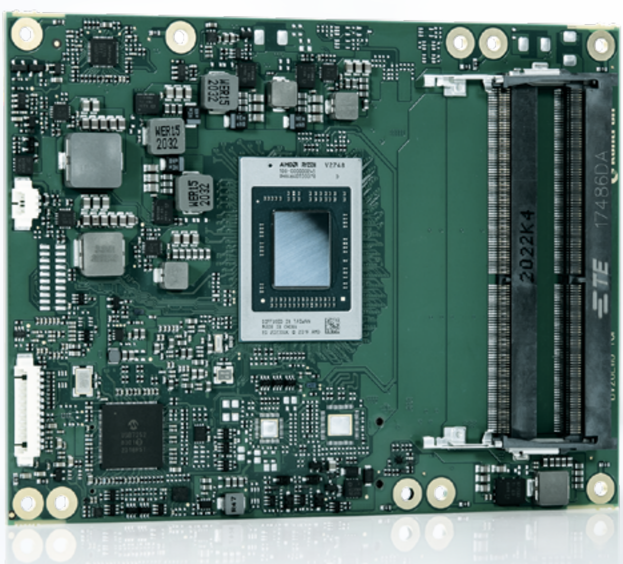
But how can developers incorporate this graphics and AI-rich processor technology into their individual designs as quickly, efficiently and sustainably as possible? Since medical devices often have very specific individual requirements for which they need a customized set of interfaces, Computer-on-Modules are perfect for this purpose, especially PICMG COM Express® modules. COM Express® Computer-on-Modules integrate all important computing core features, such as processor, graphics and main memory. Plus, they offer a comprehensive set of standardized interfaces as a standardized and therefore interchangeable building block. Developers can simply take these components and integrate them via an application-specific carrier board – for example, to connect the signal converters of an ultrasound device – to arrive much more quickly and efficiently at a solution that exactly matches the specific application requirements.

This means developers stay within their area of expertise at all times, and benefit from an all-round high level of design security. The separation of carrier board and computing unit is also of great advantage when it comes to certified medical devices. For instance, there is no need to completely re-qualify an EN 60601 certified carrier board when the Computer-on-Module is replaced with another one off the shelf. Incidentally, this also makes an interesting cost argument.

Since Computer-on-Modules decouple the application from the processor technology, scaling design performance or upgrading to a newer module becomes a simple matter of swapping one module for another. This helps to implement an entire product family with different performance levels on the basis of a single design, and significantly extends the product life with minimal total cost of ownership – even beyond the service life of the current processor generation. However, the latter will be needed only in rare cases as the AMD Ryzen™ Embedded V2000 processors have a guaranteed availability of 10 years. In addition, the modules always come with a complete set of drivers and hardware-related software for all major operating systems, which further simplifies deployment.

THE NEW KONTRON COMe-bV26 COM EXPRESS® BASIC MODULE

The new application-ready COM Express® Basic module COMe-bV26 from Kontron combines all these advantages. It is based on the COM Express® Basic standard from the PICMG and comes in 4 different variants with 6 or 8 Zen 2 cores. Compared to alternative designs in the smaller COM Express® Compact form factor, the Kontron Basic module with a footprint of still only 125 x 95 mm has space to integrate more application-ready features – among them a soldered NVMe SSD to provide up to 1 TByte of fully integrated, extremely robust and fast storage onboard. As this is now connected via PCIe x4 GEN3, it enables the highest SSD performance. An optional PCIe hub, which can be used to run up to 8 additional PCIe Gen 3 lanes, provides further flexibility. This allows the connection of more application-specific peripherals, such as dedicated AI accelerators, additional I/O controllers, or further NVMe storage devices on the carrier board. For added reliability, there is a second flash memory that can be used for BIOS recovery when maintenance is required.



// The COM Express® Basic module offers a soldered NVMe SSD for up to 1 TByte of fully integrated, extremely robust and fast onboard storage.

The slightly larger footprint also simplifies cooling since the heat is dissipated over a larger area, which avoids hot spots. This is especially important for medical devices that must not have any fans or vents as the heat can then only be dissipated via the casing. The improved cooling also makes it much easier to deliver the full 58 watt TDP performance within the permitted temperature range of -40 °C to +85 °C.

The new long-term available COM Express® Type 6 Basic modules (95 x 125 mm) with AMD Ryzen™ Embedded V2000 processors cover an extremely wide TDP range from 10 to 58 watts, with several options to adjust the TDP to match the exact system design requirements. Up to 64 GByte DDR4 3200, optionally with ECC, are provided via two SODIMM sockets. The integrated AMD Radeon™ Vega graphics card drives 4 independent 4k monitors via 3x DP++ as well as eDP, or alternatively via LVDS or VGA. Additional graphics cards or GPGPU accelerators can be connected via PEG. The 7 compute units of the AMD Radeon™ graphics can also accelerate AI inferences in GPGPU mode. For application-specific extensions, 8x PCIe Gen 3 and 8 optional additional PCIe Gen 3 ports are provided. In addition, up to 4x USB 3.1 and 4x USB 2.0 are available. For networking real-time applications, the carrier board provides 1x GbE with optional TSN support. In cases where the up to 1 TByte NVMe onboard storage is not enough, it can be expanded via 4x SATA with conventional SSDs or HDDs. Board support packages for Windows 10 IoT Enterprise, Linux and VxWorks 7.0 round off the feature set of the new COM Express® Basic module.

THE FEATURES OF THE AMD Ryzen™ EMBEDDED PROCESSOR BASED COMPUTER-ON-MODULES IN COMPARISON

		COMe AMD Ryzen™ V2000	COMe AMD Ryzen™ V1000
CPU	MICROARCHITECTURE	Zen 2	Zen
	MANUFACTURING TECHNOLOGY	7 nm	14 nm
	CPU CORES / THREADS (MAX)	8 / 16	4 / 8
	BASE CLOCK (MAX)	2.9 GHz	3.35 GHz
	BOOST CLOCK (MAX)	4.25 GHz	3.8 GHz
	TDP RANGE	10 - 25 W / 35 - 54 W	10 - 25 W / 35 - 54 W
	L2 CACHE (MAX)	4	2
	L3 CACHE (MAX)	8	4
GRAPHICS	COMPUTER UNITS (MAX)	7	11
	GPU ARCHITECTURE	AMD Radeon™	AMD Radeon™
	GPU CLOCK (MAX)	1.6 GHz	1.3 GHz
	PARALLEL DISPLAYS (MAX)	4x	4x
	RESOLUTION	4k	4k
	DISPLAY I/Os	DDI1: DP++, DDI2: DP++, DDI3: DP++, VGA: -, LVDS: Dual Channel 18/24bit	DDI1: DP++, DDI2: DP++, DDI3: DP (R-Series: DDI1 & DDI2 only), VGA: -, LVDS: Dual Channel 18/24 bit
	VIDEO DECODING	4k 10/8-bit HVEC, 10/8-bit VP9 and H.264	4k 10/8-bit HVEC, 10/8-bit VP9 and H.264
	VIDEO ENCODING	4k 10/8-bit HVEC and H.264	4k 10/8-bit HVEC and H.264
MEMORY	MEMORY CONTROLLER	Dual-channel 64-bit DDR4 (up to 3200 MT/s) / Quad-channel 32-bit LPDDR4X (up to 4267 MT/s) (32 GByte total)	Dual-channel 64-bit DDR4 (up to 3200 MT/s)
	WORKING MEMORY (MAX)	64 GByte	48 GByte
	ECC SUPPORT	yes	yes
I/Os	PCIe	4x PCIe 3.0 (up to 8 GT/s) 4x PCIe 2.0 (up to 5 GT/s) via PCIe switch1x PEG x8	Up to 5x PCIe 3.0 (On request: 6x without Ethernet) On request: Up to 8x PCIe x1 with 4x PCIe 3.0 + 4x PCIe 2.0. up to 1x PEG x8
	USB	4x USB Gen3.1 Gen2 / 8x USB 2.0	4x USB Gen3.1 Gen2 1x USB 3.1 Gen 8x USB 2.0
	STORAGE MEDIA	SATA / SATA Express / 2x 4 NVMe	2x SATA / NVMe /
	ETHERNET	1x 1GbE-	1x 1 GbE
	ADDITIONAL I/Os	LPC, UART, 4x I^2C, 2x SMBus, SPI, GPIO	2x UART, 4x I^2C, 2x SMBus, SPI/eSPI, I^2S/HDA/SW, GPIO

[1] www.researchandmarkets.com/reports/4896504/computer-vision-in-healthcare-market-research

[2] www.emergenresearch.com/industry-report/ai-enabled-medical-imaging-solutions-market

[3] www.medical-design.news/praxiswissen/kontron-entwickelt-sprachsteuerung-fuer-op-roboterarm.173489.html

[4] www.microsoft.com/de-de/techwiese/news/tensorflow-directml-wird-open-source.aspx

[5] www.github.com/BVLC/caffe/tree/windows

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About Kontron – Member of the S&T Group

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

For more information, please visit: www.kontron.com

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