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Whitepaper
Server-on-Modules

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The small form factor trend has conquered the high-end industrial computing market. Intel® Xeon® processors are now available as highly integrated and rugged BGA versions. This opens the door for a new category of embedded computing platforms: Server-on-Modules. Utilizing the COM Express specification for this new module class makes a lot of sense.

In parallel with the 5th and 6th generation of Intel® Core™ processors (former codenames Broadwell and Skylake), Intel® Xeon® processors have also become available on the basis of the same microarchitecture. They are manufactured in 14nm process and integrate the CPU and GPU on a small form factor, rugged BGA multi-chip-module (package size for Gen 5 is 37.5mm x 32mm x 1.8mm).

While the Intel® Core™ processors are well suited for any 'standard' high-end applications ranging from industrial automation to medical, retail and gaming, the Intel® Xeon® processors aim for embedded, industrial and IoT server platforms. Areas of application include, for example, carrier-grade edge node servers as well as industrial cloud servers with high packing density and/or minimum footprint.

The high graphics performance of the integrated Intel® Iris™ Pro technology – useful in carrier-grade applications for content delivery platforms with real-time video transcoding of multiple streams and network functions virtualization (NFV) – will also work well in industrial applications to fulfill important situational awareness tasks, for example in autonomous vehicles or in vision-based industrial safety barriers. GPGPU-based applications can also be found in parallel deep packet inspection, content encryption and decryption and big data analytics. For server-based applications, the graphics engine delivers distributed clients a rich and responsive 3D performance for CAD, 3D modeling and video rendering.

Dedicated for applications where standard server boards fail
Some of these applications are fit for 19-inch industrial server designs that were built on the basis of standard industrial motherboards such as ATX and its derivates. But most of the new embedded server applications are more space-constrained and demand a highly customized feature set. So the time has come to define a server class of computer modules to be able to perform the required customization with limited efforts.

A big advantage at this stage is the availability of the open standard COM Express Computer-on-Module specification which is hosted by the PCI Industrial Computer Manufacturers Group (PICMG). This specification delivers everything that is required to design high-end industrial embedded servers. The layer design of the boards is built for high levels of EMC compliance in harsh industrial environments. The two double-row SMD connectors are robust and offer 440 pins for numerous high-speed interfaces. In addition, COM Express is optimized for the high performance interfaces of standard computer technologies and meets the highest ruggedization demands thanks to a stable connection to the application-specific carrier board. In many cases, it is specifically the high-end designs that rely on COM Express, especially when

the standard feature set of the motherboards does not meet the design requirements or space is limited in the application.

COM Express provides the solid base

So the only question is whether these new SOC server processors fit on the form factor. And yes, they do: The 125mm x 95mm sized COM Express Basic form factor fits for the Intel® Xeon® E3 v4 and v5 generations as long as engineers don't want to have 4 banks of DDR4 RAM which cannot be designed onto the modules. But everything that can be sufficiently served today with up to 32GB RAM is perfectly served with COM Express. That is a great advantage because embedded server designers can now utilize the entire eco system that has been built around this form factor.
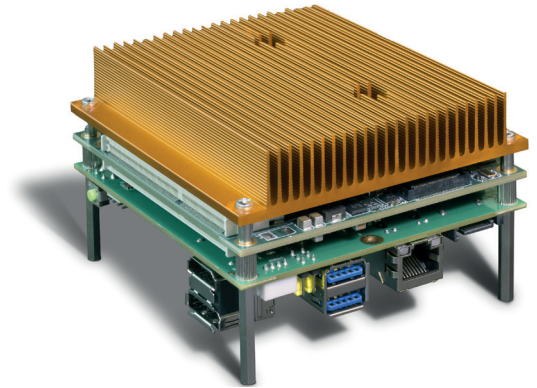

Figure 1:
Caption: Embedded server designs built on the basis of Server-on-Modules can be as compact as 125mm x 95mm.

Some people might raise the objection that they cannot use the entire I/O feature set of the new Intel® Xeon® processors. And yes, that is true. But on the other hand, standards are not built to fulfill everybody's needs. They are better built in accordance with the Pareto principle to suit 80% of applications because it reduces costs not to fulfill the needs of the last 20%. The 440 pins of the COM Express Type 6 specification offer a huge set of interfaces for that 80% of applications. In most cases, they will by far exceed the demands of high-end embedded, industrial and IoT edge node servers. And for the carrier-grade and industrial data center server class, it could be an idea to modify the setup of the display interfaces to provide even more high-speed I/O interfaces. So why not use the same approach again to create a real server-class COM Express module? This would be a very attractive option compared to a full custom design. COM Express can definitely cater for all embedded server demands in a small form factor, either as a standard design or as a derivate with revised interfaces. In any case, from now on we will more often see this new category of Computer-on-Modules, which we want to call Server-on-Modules to exactly define the application area we see for this type of embedded computing platforms. There is no doubt that the small form factor trend has conquered the high-end industrial computing market.

What distinguishes Server-on-Modules?

The answer lies in the nature of the processors themselves, the different interfaces they provide and the power and performance class they offer. On top of this, it is also self-explanatory that elaborate Server-on-Modules will come with powerful server-class tools to manage distributed IoT, M2M and Industry 4.0 applications. So they are definitely a perfect fit for many internet connected appliances. Thanks to Intel® vPro technology and an integrated board management controller with watchdog timer and power loss control, these modules are fully equipped for

remote monitoring, management and maintenance tasks, right down to out-of-band management to provide the high reliability that is a must for all server technology.

The first new Server-on-Modules

Imaging modalities in the medical market continue to improve; the benefits that visualisation offers is proving to be incredibly important in diagnosis, while the use of less intrusive forms of surgery are increasingly enabled by smaller cameras and higher resolution displays.

The first platforms of this new server class of Computer-on-Modules are equipped with 5th generation quad-core Intel® Core™ and Xeon® E3 v4 processors and offer 6MB of L2 cache with a TDP of 47 watts. The following Intel® processors are supported: Core i7-5700EQ, Core i7-5850EQ, Xeon E3-1258L v4 and E3-1278L v4. Thanks to super-fast 32GB 1600 DDR3L memory support, the modules meet server-grade requirements and are specifically designed for use in data-intensive applications. With support for AVX 2.0, SSE 4.2 and OpenCL 2.0, the new modules are also capable of processing high-parallel tasks quickly and efficiently.

The integrated Intel® Gen 8 HD Graphics scales to Intel® Iris™ Pro P6300 with 48 execution units. This allows operation at 60 Hz of up to 3 independent 4K displays (3840 x 1260) via HDMI 1.4, DVI and DisplayPort 1.2. An additional dual-channel LVDS output is provided while OpenGL 4.3 and DirectX11.2 ensure high-quality images and the latest 3D features. The integrated video transcoder relieves the CPU by providing H265, H264, MPEG2 and VC1 video streams in real time.

The modules offer a wide range of I/O interfaces, including PCI Express Graphics, seven PCI Express Gen 2.0 Lanes, 4x USB 3.0, 8x USB 2.0, I²C and LPC. SSD, HDD and BluRay mass storage can be added via 4x SATA 3.0, including support for RAID levels 0, 1, 5 and 10.

Thanks to Intel® AMT 9.1 and the integrated board management controller, including watchdog timer and power loss control, the modules are fully equipped for remote monitoring, management and maintenance tasks, all the way up to out-of-band management – which in the age of the Internet of Things has become expected of all embedded servers. The modules support all current Linux and Microsoft operating system versions and are already prepared for Microsoft Windows 10.
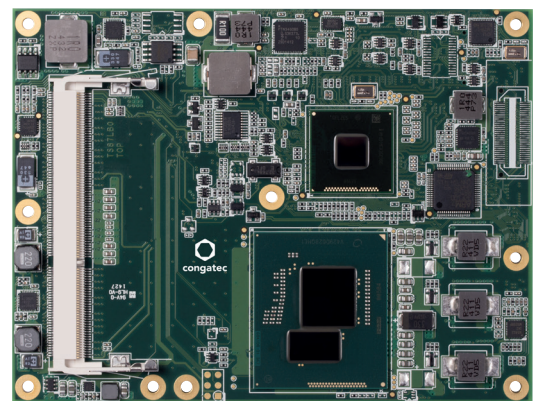
Figure 2:
Caption conga-TS97: congatec's COM Express Basic module with 5th gen Intel® Core™ and Intel® Xeon® v4 processors delivers server-class computing performance and offers integrated Intel® Gen 8 HD Graphics that scale to Intel® Iris™ Pro P6300 with 48 execution units.

The first generation of available Server-on-Modules supports the following processor variants:

Processor	Cores	Smart Cache [MB]	Clock [GHz]	Turbo Boost [GHz]	TDP [W]	Graphics
Intel Core i7-5700EQ	4	6	1.9 - 2.6	3.4	47 / 37	Intel HD Graphics 5600
Intel Core i7-5850EQ	4	6	1.9 - 2.7	3.4	47 / 37	Intel Iris Pro Graphics 6200
Intel Xeon E3-1258L v4	4	6	1.8	3.2	47	Intel HD Graphics 6200
Intel Xeon E3-1278L v4	4	6	2.0	3.3	47	Intel Iris Pro Graphics P6300

A data sheet plus additional information on the new conga-TC170 computer module are available at: http://www.congatec.com/en/products/com-express-type6/conga-tc170.html

The second generation of Server-on-Modules

The second generation of Server-on-Modules are equipped with the latest 6th generation 14nm Xeon® v5 and Intel® Core™ processors. They feature a TDP of 25-45W, up to 8MB smart cache and super-fast 2133 DDR4 memory up to 32GB, implemented as ECC memory for safety-critical applications in the Intel® Xeon variants. For energy-efficient 24/7 operation, the new modules support disconnected standby in place of the legacy S3 mode. With disconnected standby, switching from energy-saving sleep mode to full performance takes less than half a second; as a result, systems can go into sleep mode more frequently without affecting usability and responsiveness.
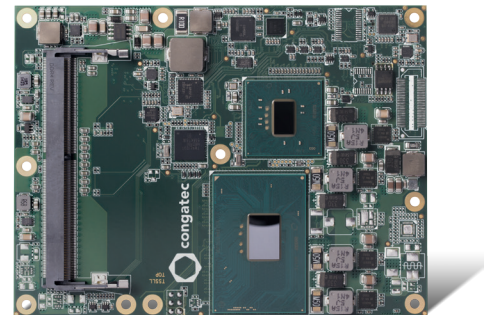

Figure 3:
Caption conga-TS170: congatec's COM Express Basic module with 6th gen Intel® Core™ and Intel® Xeon® processors offers server-class computing performance and up to 32GB of DDR4 memory..

The integrated 9th generation Intel® HD Graphics 530 supports DirectX 12 for even faster Windows 10 based 3D graphics on up to 3 independent 4K (3840 x 1260) displays via HDMI 1.4, DVI or DisplayPort 1.2. For legacy applications, a dual-channel LVDS output and optional VGA are available. Thanks to hardware support for the decoding and now also the encoding of HEVC, VP8, VP9 and VDENC, it is for the first time possible to stream HD video energy-efficiently in both directions.

In addition to PCI Express Gen 3.0 Graphics (PEG), the choice of available I/O interfaces includes 8x PCI Express Gen 3.0 lanes, 4x USB 3.0, 8x USB 2.0, LPC and I²C. SSD, HDD and BluRay mass storage can be connected via 4x SATA 3.0, including RAID 0, 1, 5, 10 support. All major Linux and

Microsoft Windows operating systems are supported, including Windows 10. A comprehensive set of add-ons for easier design-in – such as cooling solutions, carrier boards and starter kits – completes the offer.

Currently available second generation Server-on-Modules support the following processor variants:

Processor	Cores	Smart Cache [MB]	Clock GHz]	Turbo Boost [GHz]	TDP [W]	Graphics
Intel Core i7-6820EQ	4	8	2.8	3.5	45	Intel HD Graphics 530
Intel Core i7-6822EQ	4	8	2.0	2.8	25	Intel HD Graphics 530
Intel Core i5-6440EQ	4	6	2.7	3.4	45	Intel HD Graphics 530
Intel Core i5-6442E	4	6	1.9	2.7	25	Intel HD Graphics 530
Intel Core i3-6100E	2	3	2.7	-	35	Intel HD Graphics 530
Intel Core i3-6102E	2	3	1.9	-	25	Intel HD Graphics 530
Intel Xeon E3-1505M v5	4	8	2.8	3.7	45 / 35	Intel HD Graphics P530
Intel Xeon E3-1505L v5	4	8	2.0	2.8	25	Intel HD Graphics P530

A data sheet plus additional information on the new conga-TS170 computer module are available at: http://www.congatec.com/products/com-express-type6/conga-ts170.html

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About congatec AG

Headquartered in Deggendorf, Germany, congatec AG is a leading supplier of industrial computer modules using the standard form factors Qseven, COM Express, XTX and ETX, as well as single board computers and EDM services. Congatec's products can be used in a variety of industries and applications, such as industrial automation, medical, entertainment, transportation, telecommunication, test & measurement and point-of-sale. Core knowledge and technical know-how includes unique extended BIOS features as well as comprehensive driver and board support packages. Following the design-in phase, customers are given support via extensive product lifecycle management. The company's products are manufactured by specialist service providers in accordance with modern quality standards. Currently congatec has entities in Taiwan, Japan, China, USA, Australia and the Czech Republic. More information is available on our website at www.congatec.com or via Facebook, Twitter and YouTube.

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