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Technical article

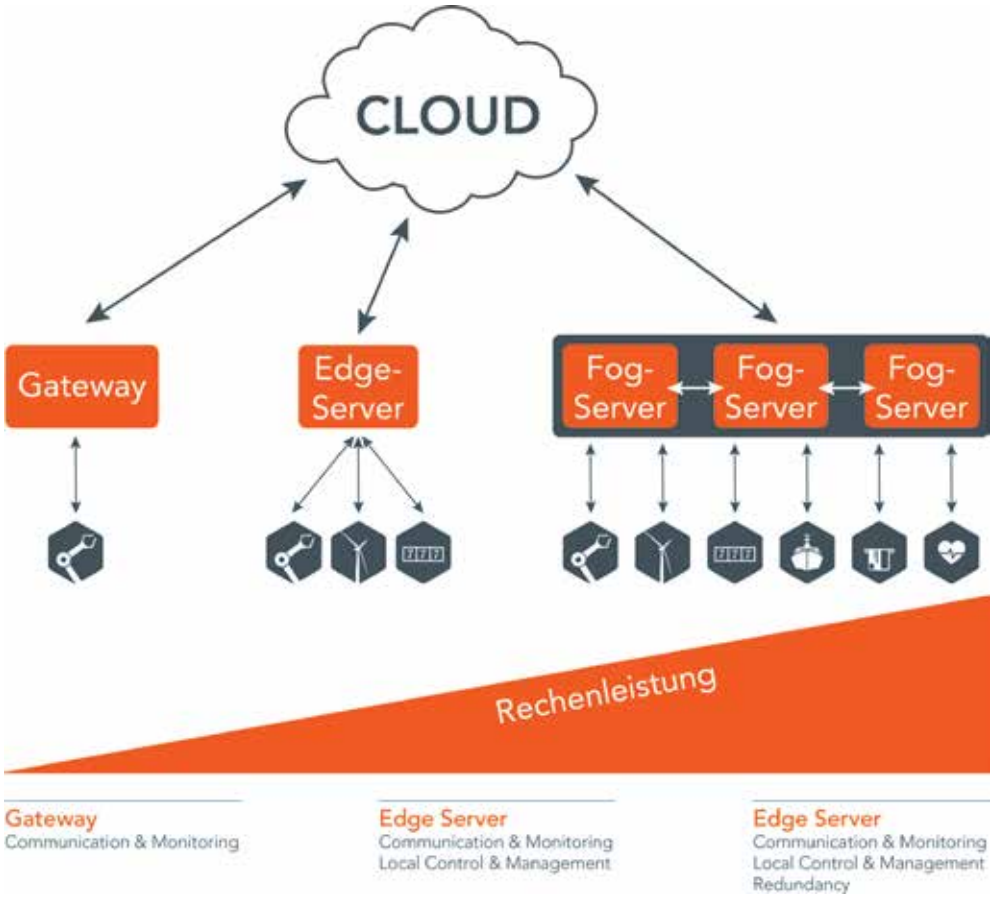
High-performance at the edge of the IIoT

Server-on-Modules for Industrial Edge and Fog Computing

High-performance at the edge of the IIoT

The Internet of Things and increasing network bandwidths are significantly changing the way applications are designed. Edge and fog computing provide extremely powerful server technology at the edge of the Industrial Internet of Things (IIoT). Server-on-Modules from congatec with Intel® Xeon® processor technology target precisely this application field.

Bringing clarity to nebulous terminology



In addition to the bridge functions of gateways, edge and fog servers also provide complete control and management of applications locally.

Edge servers are deployed on the verges of the Internet. Because they perform important tasks for the network as well as the local applications, they are – in addition to IoT gateways – the most important building block for the IIoT. Fog computers fulfil very similar functions. But what exactly is fog computing? The term was coined in analogy to cloud servers: In contrast to clouds, fog settles in the valley. Clouds are high up in the network, fogs are low down at the local IIoT level. This sums up the difference between cloud and fog servers. Unlike edge servers, fog servers add real-time virtualization across multiple systems to the picture. So, fog servers provide a highly

reliable and – depending on the design – real-time capable local infrastructure for the Internet of Things.

Client/server computing in the IoT era

Unlike IoT gateways, edge/fog servers don't just function as a bridge, but provide complete control and management functionality for the local applications, which are built by the servers and the slim clients, i.e. smart sensors and all types of devices. The borders are often fluid. Why would one need such a local IIoT infrastructure with edge and fog servers, which is basically a new way of client/server computing with complementary gateway functions? There are several reasons:

- For a start, data volumes are continuously increasing. In the commercial segment, an example is on-demand streaming of videos that need to be decoded in accordance with the client. This requires transcoding capacity at the edge to optimize video resolution and compression in line with the respective bandwidth and resolution of the end device. If one were to handle all traffic via a centralized server, the network would currently be hopelessly overloaded. If, on the other hand, all computations would have to be executed by the smart device itself, many new applications would be impossible to implement.
- Latency is higher when data and apps are retrieved from a central cloud instead of locally. Applications which need to react quickly require local performance. Compared to cloud servers, local servers can therefore increase quality of service.
- Real-time capability is only feasible for deterministic network designs, and also requires that all application data and responses are delivered within a defined time limit. A centralized cloud hierarchy, sometimes with transoceanic communication paths, limited WAN bandwidth and singular servers, cannot guarantee this. Locally distributed fog servers also offer increased availability through redundancy.
- Data traffic via centralized servers is also increasing: If one were to transmit all data from the sensors, sometimes delivered at high frequencies, to a centralized big data platform, the network would very quickly be overloaded by the number of data packets. Pre-processing of data therefore makes a lot of sense.
- Last but not least, if local applications consist only of smart sensors and actors – from RFID tag to motion controller – a local server that resides at the edge of the IIoT is required for all these clients in order to configure the many individual parts into a whole and to form an application.

IoT servers are in big demand

There are many applications that can benefit from high-performance edge and fog servers. In the industrial sector, Industry 4.0 installations are prime examples. In the energy segment, they are used in smart grids to monitor wind farms or control micro grids with various renewable local sources. In facility management, it is a matter of managing complex sites. In the transportation sector, server technology is found in smart railway carriages and wagons where it is used to improve inventory management or to operate infotainment systems. And the latter are of course also found on airplanes and coaches. Autonomous driving also requires

Measuring 125mm x 95mm, edge/fog server designs with Server-on-Modules have an extremely compact footprint.

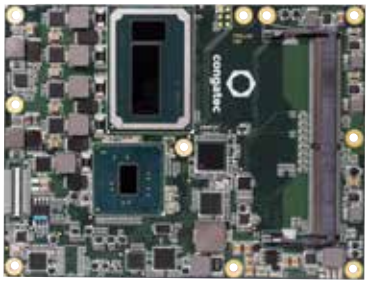
powerful on-board computers. The same applies to all other autonomous vehicle applications, such as drone surveillance. Other target markets are found, for example, in video surveillance and the DOOH/digital signage segment. Yet another large application field is the medical sector with IoT connected devices in the hospital as well as in home care and diagnostics. Lastly, there are Smart City applications and carrier-grade infrastructures – for all conceivable types of IoT services.

Defying harsh environments

The fact that there are so many different IIoT applications that require edge or fog computers calls for a robust, highly flexible server technology with a long-term availability. Since most of the new edge, fog and embedded servers are an integral part of the devices or machinery, they underlie space constraints. It would therefore be advantageous to implement all necessary interfaces directly on the board level. The most efficient way to achieve this is with standardized computer modules and application-specific carrier boards. For this purpose, congatec defined a new class of server-grade computer modules, so-called Server-on-Modules. They make it easy to utilize the latest highly integrated server technology as application-ready components and to implement the necessary customizations with limited effort and cost.

The third, forward-looking option is panel control via the MIPI Display Serial Interface (DSI) as specified by the Mobile Industry Processor Interface Alliance (see http://mipi.org/specifications/display-interface). Today, displays supporting MIPI DSI are found mostly in smartphones. While generally smaller, they are nevertheless high-resolution displays, which are produced in very large quantities. Just like eDP, MIPI DSI is based on fast differential serial line pairs, but uses different data rates and protocols.

Standards are the key to success



congatec COM Express Basic modules with Intel® Xeon® processors provide server-class computing performance and up to 32GB ECC DDR4 RAM.

A big advantage for the new Server-on-Modules is the availability of the open COM Express standard for Computer-on-Modules, which is hosted by the PCI Industrial Computer Manufacturers Group (PICMG). This specification provides everything needed to design industrial high-end embedded servers. The PCB layers are designed for high EMC compatibility in harsh industrial environments. The two double-row SMD connectors are robust and offer 440 pins for numerous I/Os. COM Express is optimized for standard high-performance computer interfaces; at the same time, it meets the highest robustness requirements thanks to a stable connection to the application-specific carrier board. High-end embedded designs therefore rely on COM Express especially if the standard features of the motherboard do not meet the design requirements, or if the application has limited space. So why not use the same specification to develop fully server-class COM Express modules, and how would they differ from traditional Computer-on-Modules?

Server-on-Modules have a lot going for them

Server-on-Modules differ from traditional Computer-on-Modules in processor type, feature set, power and performance class. Advanced Server-on-Modules provide powerful server-class tools to help manage distributed IoT, M2M and Industry 4.0 applications, making them the perfect fit

for many devices connected via edge or fog servers. Providing server-class remote management and an integrated baseboard management controller with watchdog timer and power loss control, these modules are ideal for remote monitoring, management and maintenance tasks including out-of-band management – a must for industrial server technology, if it is to offer high reliability.

Features to bank on

The world's first Server-on-Module platforms presented by congatec are equipped with the latest 5th Gen Intel Xeon server processors and define a completely new performance class of COM-based embedded computing designs. The conga-TS170 module, for example, is available with different Intel Xeon processors: For applications that require particularly high parallel processing or graphics performance, the version with Intel Xeon E3-1515M v5 processor and Intel® Iris™ Pro graphics is the best fit. The GPU of the Server-on-Module provides 128 MB eDRAM and, thanks to 72 execution units, three times the parallel processing power of the Skylake architecture without Iris graphics. This gives developers of highly compact COM Express based server designs access to a new level of performance that would have previously required a dedicated graphics unit.

For applications demanding high media-processing capacity, the most suitable versions are those featuring the latest Intel Xeon processors E3-1578L and E3-1558L that Intel introduced at Computex and that congatec had integrated in its Server-on-Modules by the time of the launch. They also offer 128 MB eDRAM, and a maximum TDP of 45 watts. However, with up to 700 MHz the integrated Intel Iris Pro graphics unit provides double the base clock speed. This increases media processing power significantly since the hardware accelerators that are used, e.g. for fast video transcoding, invariably run at base clock and not in graphics turbo mode. This makes them Intel's first real-time HEVC transcoding processors for up to two 4k HEVC output streams or up to 15 full HD HEVC (1080p) streams. And with up to 32 GB address space for video memory (compared to 1.7 GB for the Intel Xeon processor E3-1505M), reliable media performance is guaranteed even at high data loads. This benefits infrastructure applications for video conferencing, surveillance cameras and video-on-demand offerings.

For managing distributed IIoT edge and fog servers all conga-TS170 variants also provide powerful server-class tools. Thanks to Intel® vPro™ technology and congatec's board management controller with watchdog timer and power loss control, the Server-on-Module is also fully equipped for remote monitoring, management and maintenance, including out-of-band management.

What else counts?

Edge and fog computers are the most important platforms for IIoT applications next to IoT gateways. Server-on-Modules provide developers with the necessary performance, firmware and middleware to realize such innovative applications. If developers additionally receive application-specific hardware-related software support from the Server-on-Module manufacturer, they can quickly develop custom industrial-grade edge and fog server applications. With congatec's optional Embedded Design & Manufacturing Services for its Server-on-Modules, even complete custom system designs can be implemented quickly. There is no need for application designers to worry about the details of the hardware design. With the appropriate starter kits, they can immediately test the embedded firmware and middleware. And early prototypes, which as a rule can immediately be used for first field tests, are available in next to no time.

COM Express Type 7 – the next step in the evolution of Server-on-Modules

The next step in the evolution of Server-on-Modules will firmly embed this new module class from congatec in the upcoming COM Express specification 3.0. In fact, the Type 7 pinout – which is to be specified for the first time in the new revision – is specifically tailored to the needs of fog and edge server applications. Its main focus is the provision of powerful connectivity with up to four 10 Gigabit Ethernet ports on the module, using the pins of the three DDI graphic interfaces of the Type 6 pinout. This is a smart and largely compatible reclassification as server chips don't generally offer graphics interfaces and server applications don't require multiple high-resolution graphics output locally. As editor of the PICMG specification, congatec is actively involved in developing the COM Express 3.0 standard. Customers can therefore put their trust in congatec as a competent and reliable partner.

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