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Whitepaper

# **Benefits of the new Intel® Atom™ processors „Apollo Lake“**

# Next generation Intel® low-power processors and their benefits



congatec supports the new low-power Intel® Atom™, Celeron® and Pentium® processors (Codename Apollo Lake) on six different form factors: Mini-ITX motherboards and Pico-ITX single board computers as well as COM Express Compact, COM Express Mini, Qseven and – this is really new – SMARC 2.0 Computer-on-Modules. What makes this processor so attractive for design-in on so many different form factors?

## A quick overview

The new low-power processors from Intel® offer significantly higher performance at lower power consumption with massively improved graphics capabilities. That is the major message of the brand new low-power Intel® Atom™, Celeron® and Pentium® processors, launched on October 25, 2016. Designers across the broad spectrum of embedded markets will find essential value in the improved performance-per-watt at a power envelope of only 6 to 12 watt. Additionally, new graphics capabilities are fueled by the powerful Intel® Gen 9 graphics engine, which was previously only available at the high-end level of Intel® Core™ processors. Extended temperature support, accommodating ambient temperatures ranging from -40° C to +85° C, as well as comprehensive real-time capabilities rounds out the feature set. All this makes the new low-power processor generation very attractive, blending performance, price and embedded longevity.

## The new BGA package

The 14 nm BGA (Ball Grid Array) package of the new low-power processors now has 1296 pins, or 10 % more as compared to the 1170 pins of its predecessors. As a result, the new processors'

BGA options have a 10% larger footprint, measuring 31x24 mm or 744 mm<sup>2</sup> compared to earlier processors measuring 25 x 27 mm or 675 mm<sup>2</sup>.

## Processor

The Intel® Pentium® Processor N4200 offers a SYSmark 2014 improvement of round about 30% on Windows in contrast to the earlier Intel® Pentium® Processor N3710. With this significantly increased processor performance over the previous generation platform, the latest Intel® Pentium® and Celeron® processors give embedded and IoT platforms the computing power they need.

Processor	Cores	Intel® Smart Cache [MB]	Clock/ Burst [GHz]	TDP [W]	Graphics Execution Units
Intel® Pentium® N4200	4	2	1.1 / 2.5	6	18
Intel® Celeron® N3350	2	1	1.1 / 2.4	6	12
Intel® Atom™ x7-E3950	4	2	1.6 / 2.0	12	18
Intel® Atom™ x5-E3940	4	2	1.6 / 1.8	9	12
Intel® Atom™ x5-E3930	2	1	1.3 / 1.8	6.5	12

## Battery performance

At performance ranges similar to earlier processor generations, the battery of the new Intel® Celeron® or Pentium® processor is expected to last approximately 15% longer. Data for the Intel® Atom™ processors is expected to demonstrate a similar advantage.

## Improved memory performance

Improvements in memory performance are enabled by new support for LPDDR4 RAM with up to 2400 MT/s. Compared to LPDDR3 or DDR3L RAM, both performing at 1867 MT/s, this delivers an improvement of approximately 30 %. The new processor's maximum memory bandwidth is also improved from 25.6 GB/s to 38.4 GB/s; an increase of 50 % compared to its predecessor. For maximum flexibility in memory design, the architecture also supports 16 GB SODIMM or 8 GB memory down.

For DDR3L RAM implementations, the new processor generation now supports dual-channel error correction code (ECC), a critical requirement for safety applications that demand single failure tolerance. In contrast to the earlier processor generation, this empowers designs for critical real-time embedded applications.

## New graphics performance

The Intel® Gen 9 graphics engine, initially developed for high performance Intel® Core™ processors, is now built into low-power new Intel® Atom™, Celeron® and Pentium® processors as well. Up to 18 execution units are now offered instead of up to 16, including support for 4K decoding/encoding of H.264 and VP8 as well as decoding of HEVC. Performance improvement is estimated to be three times higher compared to the extended temperature range options supporting Intel® Atom™ processors with codename Bay Trail. Compared to low-power processors with codename Braswell, performance is approximately 45 % higher in accordance to the 3DMark Skydiver

Graphics Score benchmark of the Intel® Pentium® Processor N4200 vs Intel® Pentium® Processor N3710.

### Supported display resolutions

4K support is now standard even for low-power segments. The new Intel® Atom™, Celeron® and Pentium® processors support up to three 4K displays with resolutions up to 4096 x 2160 @ 60 Hz. Earlier processor generations offered a mix of support with lower resolutions and only 1x 4K support at 30 Hz.

### Copy protection of videos

Copy protection of videos is improved by new processor generation's support of HDCP 2.2 decryption and encryption of multiple streams.

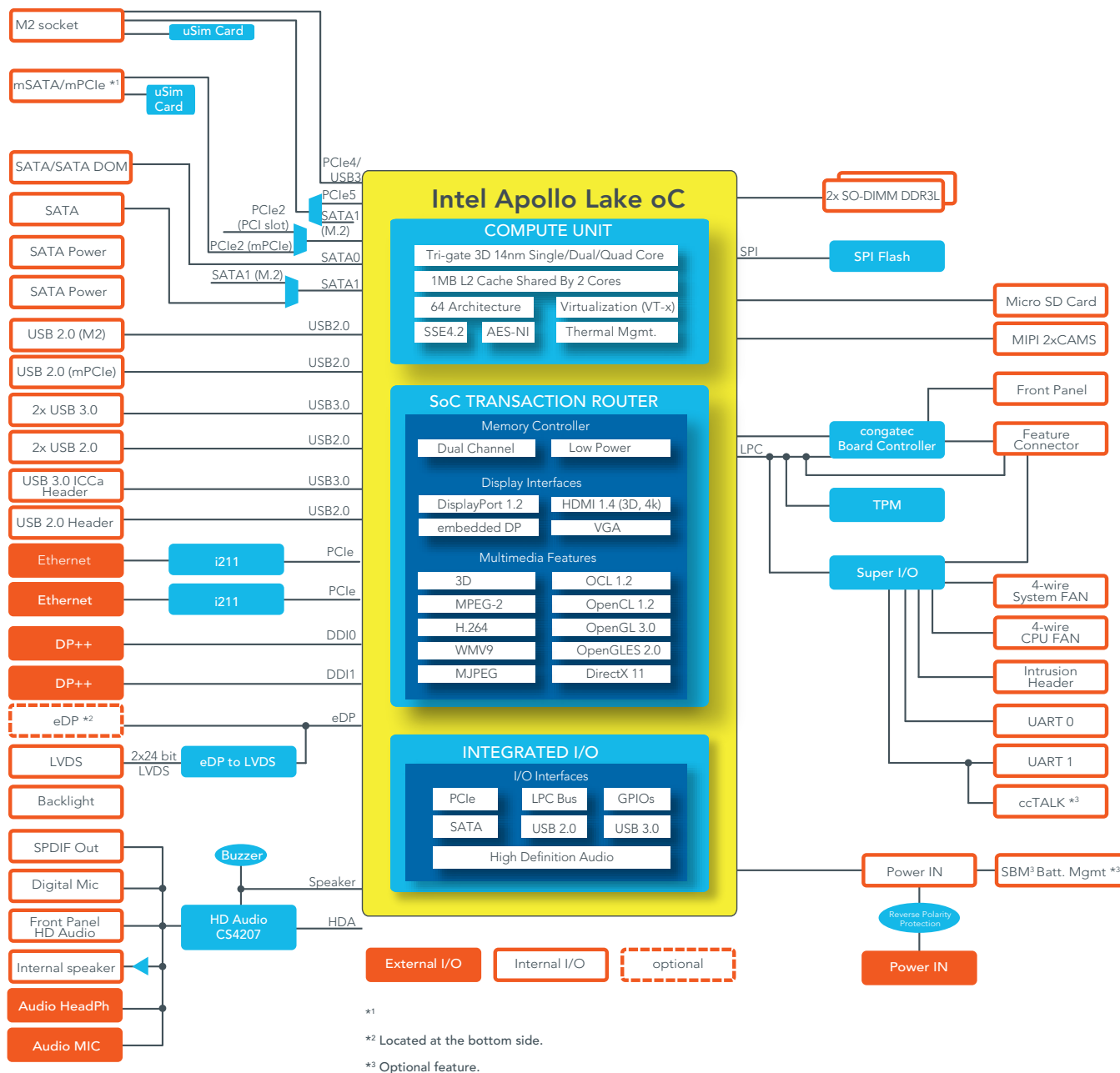
### Camera image processing

Camera image processing capabilities have significantly improved with the new Intel® Atom™, Celeron® and Pentium® processor technology. Still capture capacity is now 13 MP @ 30 FPS, vs 2.5 FPS previously. Video capture capabilities perform at 4K2K @ 30 FPS, in contrast to 1080 @ 60 FPS in earlier processors. Video with HDR can now be captured up to 1080p @30 FPS, illustrating a notable improvement from earlier generations offering no support for this feature. Up to four MIPI cameras are supported, rather than the three previously available; processing performance of up to 165 GFLOPS and four vector units (instead of two) improve image processing capabilities to a performance level even more suitable for smart camera technologies.

### Further IO and storage

The new Intel® Atom™, Celeron® and Pentium® processors supports six PCIe lanes – offering 4x PCIe 2.0 in contrast to the 3x PCIe offered by its predecessors. This adds critical value in designing feature rich IoT devices that must cater to various wireless interface standards, commonly connected to processors via PCIe lanes. Also new is the eMMC 5.0 support; compared to the eMMC 4.0 support of earlier generations, bandwidth is doubled with this improvement, extending up to 3.2 Gbit/s read performance. As a result, applications benefit from shorter boot times and faster data loads. New features also include support of 4x HSUART and 3x SPI; The processor supported IO and storage feature set is rounded out with dual SATA 3, 5x USB 3.0 and 2x USB 2.0 plus 1x client-capable USB 3.0 (all USB Type C with power delivery.) In addition, the enhanced Integrated Sensor Hub (ISH 4) and integrated Dual Audio DSP with up to 6 I2S ports further improve the audio experience for users.





Block diagram of the conga-IA5 Thin Mini-ITX board.

## OS support

The new Intel® Atom™, Celeron® and Pentium® processors support Windows 10 as well as Linux (including Yocto), VxWorks and Android (Marshmallow), and considers Windows 7 and 8 obsolete. Certain applications may need adaptation towards the new Windows OS, however it is an important step in capitalizing on new OS benefits. For example, Windows 10 IoT offers a range of security technologies such as Secure Boot, BitLocker, Device Guard and Credential Guard, ensuring that appliances are comprehensively protected from power-on to power-off. Windows 10 IoT provides flexible and necessary functions for any specific device environment, whether just a single app must be launched or access must be restricted to non-authorized USB peripherals.

Additionally, Windows activation – which is otherwise obligatory – can now be switched off to enable booting in locked network environments. Customers also benefit from integrated interoperability, adding value to IoT-typical heterogeneous device environments. In addition

to embedded appliances, these also include smartphones, PCs and laptops, as well as edge, fog and cloud servers. Development of universal apps is less complex, along with a simplified approach to enabling the security and management of IoT applications. Developers can reduce resources to these efforts and completely focus on core competencies.

### **Real-time feature adds**

The new Intel® Atom™, Celeron® and Pentium® processors also include new Precision Time Management support; the processor synchronizes its CPU with I/Os, improving determinism for directed I/Os. This technology offers a Core Time Stamp Counter as well as PCIe clock synchronization, enabling the processor to prevent cache collisions. Virtual Channel (Intel® VT) functionality is now supported to the CPU edge and includes a Memory Arbiter QOS between the CPU and Virtual Channel.

### **Back again: The extended temperature SKUs**

Because Intel® opted to drop its extended temperature support for the previous generation of Intel® Atom™ processors (codename Braswell), engineers needed to wait for the evolution from Bay Trail to Apollo Lake for this functionality. The new Intel® Atom™ processors are capable of withstanding harsh environments ranging from -40 °C up to +85 °C ambient temperature, establishing this new processor generation as an ideal, multi-purpose option for designs in various application areas. The Intel® Celeron® and Intel® Pentium® processors are designed for 0° C to +70° C.

### **Long-term availability**

According to the demands in the embedded markets, these processor families also offer long-term availability of 7 years.

### **Application areas**

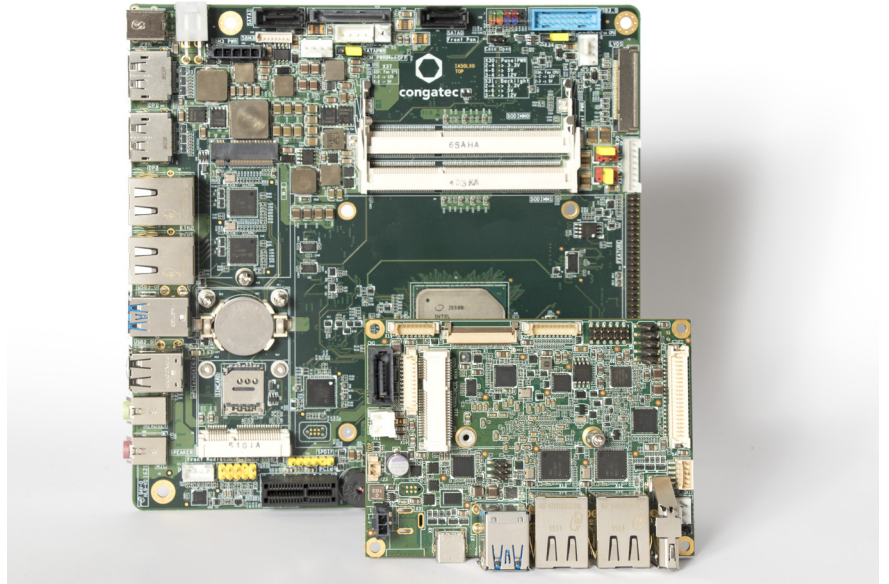
Intel® Atom™, Celeron® and Pentium® processors ideal application areas range from headless IoT gateways and industrial controls to multi-display digital signage systems, HMI and GUIs across all low-power sectors of x86 embedded computing. Rugged mobile devices as well as in-vehicle and outdoor systems are also readily supported, along with all manner of intelligent systems such as smart cities and facilities, smart metering, connected homes and intelligent cameras in the widest range of deployment scenarios.

### **Which form factor fits best?**

The broad spectrum of possible applications calls for a corresponding array of dedicated OEM system designs. This is Congatec's strongest value proposition, offering OEMs every advantage in simplifying the use of new Intel® Atom™, Celeron® and Pentium® processor technology – from six different standard form factors on boards and modules, to original design and manufacturing (ODM) services for PCBs and OEM system designs.

## Mini ITX and Pico ITX

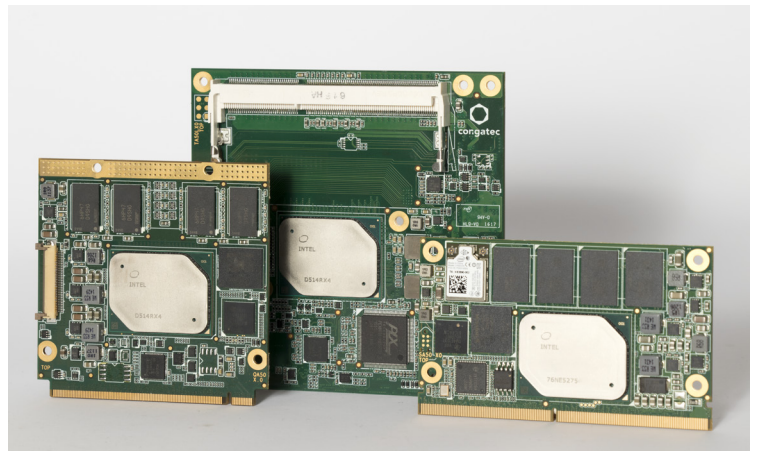
With Intel® Atom™, Celeron® and Pentium® processor-based Mini ITX and Pico ITX boards, engineers have a range of attractive options – including long-term available, industrial-grade motherboards and single board computers that fit perfectly into any standard system design that doesn't require a dedicated PCB for a customized feature set. These boards are application-ready for immediate use, however if you are facing any BSP or driver challenges, congatec's personal support is there to help. IoT engineers can also capitalize on the support of SIM cards offered by congatec's Mini ITX motherboards, greatly reducing the complexity of setting up remote connections to the board via cellular infrastructures. The Pico-ITX option offers excellent flexibility with a wide range of interfaces in a very small footprint.



conga-IA5 Thin Mini-ITX and conga-PA5 Pico ITX Single Board Computers.

## COM Express, Qseven and SMARC 2.0

For applications that require a dedicated carrier board for customized interfaces, engineers can choose a preferred module from congatec's broad portfolio of COM Express, Qseven and – this is really new – SMARC 2.0 Computer-on-Modules. Optionally, congatec also provides dedicated carrier board designs for these modules. congatec is open to any type of design cooperation, and engineers are completely free to decide whether carrier board design is the OEM's core competence or whether resources are better used by outsourcing.



conga-QA5 Qseven, conga-TCA5 COM Express Compact and conga-SA5 SMARC 2.0 Computer-On-Modules.

To help determine which Computer-on-Module form factor is the right one for your design, congatec offers guidance at a glance: COM Express compact and mini modules are for designs that require not only low power but also a more powerful Intel® Core™ processor design. To choose between SMARC 2.0 and Qseven, designers need only decide whether the system is more deeply embedded (ideal for Qseven) or more graphics- and feature-rich (optimal for SMARC 2.0.)

## WiFi, Bluetooth LE and NFC on module

It may be of interest to note the credit card-sized SMARC 2.0 offers wireless interfaces as an option, adding tangible design value. The first congatec module based on the Intel® Pentium® processor includes WiFi, Bluetooth Low Energy and NFC interface options directly implemented on the module. For designers, this more easily enables applications where distributed wireless sensors, actors and other devices need a local IoT gateway.



The new congatec Quick Starter Kit simplifies the rapid development of new SMARC 2.0 wireless IoT applications with WiFi and bluetooth onboard.

## Datasheets

Please follow these links for more information about Intel® Atom™, Celeron® and Pentium® Processors on each of the following form factors:

- Thin Mini-ITX and Pico-ITX will be released in November 2016
- Qseven  
<http://www.congatec.com/de/products/qseven/conga-qa5.html>
- SMARC 2.0  
<http://www.congatec.com/de/products/smarc/conga-sa5.html>
- COM Express Compact  
<http://www.congatec.com/de/products/com-express-type6/conga-tca5.html>
- COM Express Mini will be released in January 2017

## Simplify the use of embedded technology

If you are intrigued by the new Intel® Atom™, Celeron® and Pentium® processor family and are interested in exploring congatec's boards and modules for your new projects, please contact us at [info@congatec.com](mailto:info@congatec.com). Our engineers are more than happy to answer your design questions. At congatec, our aim is to simplify the use of embedded technology for you and your innovative applications.



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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 COM Express, Qseven and SMARC 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](http://www.congatec.com) or via Facebook, Twitter and YouTube.



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