» Whitepaper «

Intel® Atom™ SoC processors on SMARC

Simplifying engineers lives

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The SGeT Standardization Group for Embedded Technologies e.V. is currently the leading innovator for embedded form factor standards. The SGeT SMARC standard for credit card-sized modules excels in two things: a dedicated approach to all the new 'Internet-of-Things' applications and an open and barrier-free platform for different processor architectures. The recent implementation of the Intel® Atom™ SoC processor thereby serves to greatly simplify engineers' lives. It offers developers a highly scalable performance in combination with a most simple migration path across different platforms and a huge ecosystem to enable the most effective re-use of proven features, functions and interfaces, paving the way for extremely efficient designs and migrations.

CONTENT:

SMARC – The cross platform architecture

The use of ARM architecture in tablets and smartphones laid the foundation for a new generation of internet-connected, low-power devices with PC-like functionality and high-resolution displays. Energy efficiency, multi-core technology and high graphics capabilities also combine to make this processor architecture extremely interesting for embedded and intelligent system applications. To simplify the design-in of this new performance class, the SGET defined the highly successful SMARC form factor for ARM/SoC-based, credit card-sized Computer-on-Modules.

ARM developments, however, are still different compared to x86 design. As an example, until today it has not really been possible to port hardware-near code from one ARM platform to another or from x86 to ARM without substantial efforts in code adaption, even if first cross-platform development tools are appearing on the market. Therefore, only larger scale implementations have the capacity to refund the design-in efforts for ARM. Smaller scale appliances need a higher re-use quote of hardware-near code basis.

The embedded and intelligent system market targets the entire bandwidth of applications from large to small scale. Larger scales can, for example, be found in the high volume area of IoT appliances. There is, however, also a huge market for smaller scale implementations. Most of these apps are counted in hundreds or thousands per year but not in millions. Consequently, the embedded and intelligent system market needs both the spearhead of SMARC modules for large scale implementations with high dedication plus a selection of common and easy to handle SMARC modules for all the lower volume applications that don’t need to squeeze the last bit out of the code for highest energy efficiency.

All these common embedded applications now have the perfect fit with the new Intel® Atom™ SoC processor implementation which rounds off the SMARC standard seamlessly and greatly simplifies engineers’ lives. The key reasons for this are the great re-use potential of already developed application code as well as hardware-near code which allow an easy migration path across different platforms. Highly efficient new designs as well as migrations are the result.

This is why engineers are very much welcoming the launch of x86 on SMARC. An x86 launch on SMARC was, by the way, intended right from the start, as the SGET’s aim was to create a technological standardization for all the new low-power SoC processor technologies to establish a cross-architecture specification to power re-use as efficiently as possible beyond architectural boundaries. This allowed for the seamless implementation of the Intel® Atom™ without any revisions or restrictions to the specifications - a unique benefit which ensures highest design security.

Intel® Atom™ SoC – The cross application processor

Amazingly, it’s already foreseeable that SMARC modules with the Intel® Atom™ SoC processor will account for even more real sales leads from embedded engineers than SMARC modules with ARM processors due to its x86 cross application benefits. But why do engineers want exactly this new processor and not a competing x86 or ARM platform? The high acceptance rate of Intel® technologies in the embedded and intelligent systems market space is for sure one convincing argument. But the technical details of the new Intel® SoC are even more appealing.

The new Intel® Atom™ SoC offers, for example, a higher integration level with a new class of performance per watt. By reducing the previous two chip design to a fully integrated System-on-Chip design this Intel® Atom™ processor now comes in a single, space-saving BGA package of just 25 mm x 27 mm. This enables the implementation of this new performance on the smallest embedded form factors such as SMARC. And the performance increase is impressive as, compared to its predecessors, the latest Intel® Atom™ SoC processor provides twice the computing throughput.

This new SFF computing power has been achieved both by implementing the 22 nm manufacturing process and by developing the new microarchitecture. The thread-optimized processor architecture as well as quad-core options additionally help to quickly execute tasks in parallel and to ensure highest throughput for the latest appliances. All this is offered in an energy-saving design that has not been available on x86 to date. In the single-core variant, TPD stays within 5 watts and does not exceed 10 watts in the quad-core variant. A perfect fit for the wide range of new embedded and intelligent applications getting connected to the ‘Internet of Things’!

Increased graphics performance

Even though the performance increase in computing power impresses, the three times higher performance of the latest Intel® Atom™ processors as well as APIs like DirectX11 and OpenGL 3 are even more impressive. And since the integrated Intel® HD Graphics gen 7 originates from the third generation Intel® Core™ processors, developers can re-use the same roots, which greatly benefits seamless scalability. Further improvements are the enhanced video decoding capabilities, which are increasingly important for state-of-the-art, intelligent kiosk, POS/POI, digital signage and media player appliances. The integrated hardware decoder for 1080p HD video supports all major common video codes (MVC, VP8 & JPEG/MJPEG, MPEG2, H.264 and VC-1/WMV9) and offloads the CPU when playing dual-independent streams or showcasing stereoscopic 3D videos.

Comprehensive I/Os simplify designs

The new I/Os which are pre-integrated and are perfectly tailored to SMARC standard requirements are another essential part of the Intel® Atom™ SoC. For simple generic expansions, it supports, for instance, the Serial Peripheral Interface (SPI) Bus for low-power connection of a broad range of mobile class peripherals like GPS, touch controllers etc. Another ideal fit for SMARC appliances is the integrated MIPI-CSI interface for simplified camera connection, which is becoming increasingly relevant in embedded applications like security and surveillance installations and intelligent kiosk systems. High-speed extensions can be connected via fast PCIe Gen 2.0 lanes with all the benefits this generic extension interface comes with. All this is housed in a shock- and vibration-resistant, rugged SoC design supporting the extended temperature range of -40 °C to +110 °C as well as high humidity.

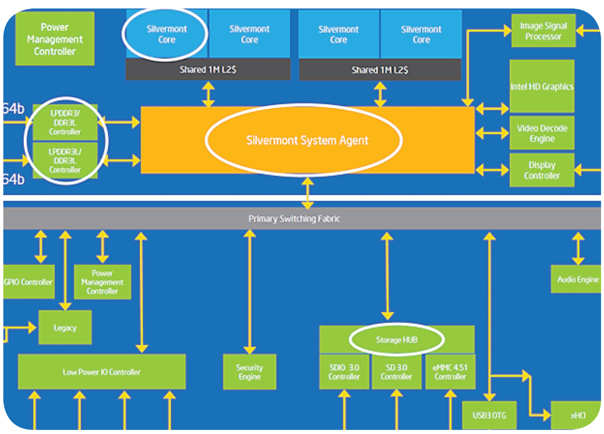

Figure 1: The new Intel® Atom™ processors integrate single- to multi-core CPUs, high performance GPUs and a broad range of I/Os on a single chip. Dedicated low-power features make it an ideal match for SMARC Computer-on-Modules.

Future re-use option: Intel® Quark™ SoCs

A further benefit for x86 engineers is the fact that the new Intel® Atom™ processor is not the only x86 processor which complies with the SMARC specification. For even lower power, more deeply embedded applications, the Intel® Quark™ X1000 processor is an interesting proposition. It is scheduled to become available on SMARC Computer-on-Modules early next year– alongside other platforms. The Intel® Quark™ SoC specifically excels with its dedication to ultra low-power applications. With a maximum TDP of just 2.3 watts, it is predestined for applications where power and size take priority over higher performance. In particular, innovative solutions in the market space of ubiquitous computing and 'Internet-of-Things' will benefit from the Intel® architecture instruction set compatibility thanks to its high re-use potential and thus optimized costs and development times. Incidentally, Intel® Atom™ SoC and Intel® Quark™ feature quite a comparable set of interfaces. This simplifies the scalability of applications even further, as developers can use all these x86 modules as a drop-in replacement without having to carry out major adaptations for code and drivers. So there are indeed perspectives for further x86 implementations. For application engineers, the most appealing thing is the capability to stay within their familiar ecosystems.

The x86 ecosystem – a treasure chest for re-use

The re-use perspectives within the x86 ecosystems are very diverse and present engineers, so to speak, with a big treasure chest. This starts with operating systems which are simple to install, including the new touch-screen technologies supporting Windows 8 which can be deployed on each x86 system by simply following the installation routines, and continues with offerings from third party software vendors that provide countless features and functions for just about any application. The most important factor and what makes the crucial difference for efficient re-use options is the hardware-near software support from both the x86 silicon vendors and the embedded system vendors. Let's first have a look at the re-use options offered by silicon vendors.

Re-useable options from silicon vendors

Besides generic support with drivers, tools and management functions, silicon vendors offer additional hardware-near building blocks e.g. for connectivity and security. The 'Intel® Gateway Solutions for the Internet-of-Things' (formerly codenamed Moon Island) are one outstanding offering for such building blocks. They are available for Intel® Atom™ processors as well as for Intel® Quark™ SoCs so they are scalable over different platforms as well. As application-ready, integrated building blocks, they help engineers to reduce costs and time within the development process of distributed intelligent systems with enhanced IoT functionality.

The Intel® Gateway Solutions for the 'Internet-of-Things' integrate building blocks such as the Wind River Intelligent Device Platform XT 2.0 and the McAfee Embedded Control 6.1. By integrating such comprehensive new security and code protection features and making them available more or less 'out of the box', engineers can easily step up security for their new 'Internet-of-Things' applications currently being developed and launched in the market.

Stepping up security is essential and for any new 'Internet-of-Things' application it is mandatory. But many OEMs lack the time and resources to carry out the intrinsic implementations on their own. Therefore they require further support from the embedded system vendor. These should provide them with computing platforms with increased designed-in security as well as additional software services because only this ensures a really streamlined and highly efficient development process. The SMARC-based Kontron Box PC KBox A-201 mini is one example of such an application-ready platform. The advantage for developers is that they can even use it when evaluating their individual x86 based SMARC designs. As can be seen, embedded system vendors can very effectively help customers to deploy re-useable silicon vendors' offerings.

Figure 2: More intelligence on-board: Kontron's forthcoming SMARC modulebased Box PC KBox A-201 mini supports Intel® Gateway Solutions for the Internet of Things (illustration similar)

Re-use options from embedded system vendors

Embedded systems vendors also try to implement even more value adding features that can be re-used by engineers to further simplify their designs. As an example, Kontron standardizes with KEAPI the application programming interfaces of their boards. Upon customer's request, Kontron also delivers pre-configured OS images tailored to the customer specific application. So it becomes obvious that it really does make a difference for engineers whether they only get barebone hardware or they get a bunch of value adding embedded features, which are often offered application-ready, pre-integrated, and ready for (re-)use.

KEAPI – uniform remote management capability

KEAPI (Kontron Embedded Application Program Interface) is a cross-platform middleware, which simplifies control and management of hardware resources in embedded applications. Developers can use a comprehensive library of sophisticated API functions to remotely gather relevant hardware information. And this is not only applicable for SMARC modules, but also for selected COM Express® and motherboards. And here again, developers can benefit from reduced development efforts, as they can efficiently re-use the same KEAPI functions in all the latest Kontron. Additionally, Kontron offers the EAPI functionality for remote control and management, which helps OEMs improve their service and maintenance with reduced Total-Cost-of-Ownership. With KEAPI, all compatible Kontron modules and boards can be controlled via a uniform interface, which simultaneously makes them IoT-ready.

Conclusion: Use it

While previous form factor standards have been specified for only one silicon architecture, SMARC is the first available form factor that has been set up for cross-architecture usage models right from the start. Not all engineers will use the opportunity in the near future to shift their applications between x86 and ARM. Today, however, there are applications in the market that use both parallel to one another. Vendors who offer control systems or GUIs that are scalable from ARM to x86 serve as one example. So this practice is already reality and the setup of SMARC offers new opportunities for re-use in this direction that have not to date been available. And the application- and not architecture-specific designs approach of SMARC is definitely the most customer-friendly way to build specifications for new standards – even beyond form factors.

Especially in its x86 variant, SMARC offers a bunch of application-ready, hardware-near building blocks from OS, silicon and embedded system vendors that can be easily re-used. And this not only applies within a single family of processors but within the entire x86 ecosystem. Consequently, a large number of engineers will definitely benefit from the Intel® Atom™ SoC implementation on SMARC because they can really exploit re-use with x86. This ensures high investment security – and that includes all the value adding offerings from third parties. And this is where embedded system vendors' products make a real difference.

A SMARC design based on x86 finally also opens up the opportunity to one day migrate to ARM. Thus, SMARC offers engineers high re-usability and long-term investment security even for presently unknown demands which may crop up in the future. Consequently, this goes to greatly simplify engineers' lives. And this, by the way, also applies vice versa when ARM designs are to be migrated to the new x86 performance class.

SMARC advantages at a glance

With ARM and x86 designs, developers now have one unifying standard specification for both processor architectures. This dual-strategy ensures highest design security and opens up re-use options for cross-platform product families. The pin-out definition is hereby the most important and vital condition for

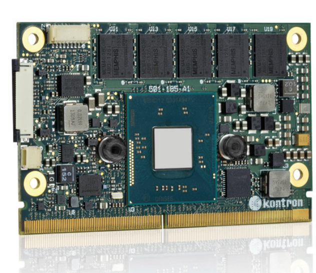

Figure 3: SMARC-sXBTi

(re-)usability. Here, SMARC offers the best of these two worlds without any compromises. SMARC uses the 314 pin MXM 3.0 connector which enables SMARC to handle the highest number of interfaces compared to competing specifications. Besides standard PC interfaces, SMARC supports all the new interfaces that are supported by both x86 SoCs and ARM processors. Two examples of these new features are the SPI Bus support and camera interfaces.

SPI for power-optimized expansions

SMARC offers the SPI Bus (Serial Peripheral Interface) for simple generic expansions. SPI is a full duplex data bus, which can connect several slaves simultaneously to one master. It offers faster transfer rates compared to other similar serial data buses such as LPC, I²C or SM Bus. The maximum clock speed is not limited, so that sufficient potential is available for future developments. The SPI Bus is also extremely energy-efficient thanks to its simple interface logic. In addition, numerous peripheral components are already available: Flash memory as well as various kinds of GPS, gyroscopic or temperature functions can easily be connected. Furthermore, there are additional microcontrollers with SPI Bus support for signal mixers, touch screens, CAN bus, Bluetooth and/or Wi-Fi as well as amplifier circuits. So with SPI, developers can easily integrate both proven PC-class as well as mobile-class peripherals.

Integrated camera interface

SMARC is also the first Computer-on-Module standard to offer a standardized camera interface. The modules feature two camera interfaces compliant to the MIPI standard, i.e. Camera Serial Interface (CSI), which enables video-based applications without the need for additional controllers. It even supports stereoscopic 3D recording. Innovative features, such as access authorization via face recognition, viewer-related content provision, contact-free operation with gesture control systems are also enabled by the camera interfaces. Using the 3D function, security applications can also be installed featuring movement and distance measurement for hazardous areas. Further application areas can be found in the fields of tele-health or service and maintenance operations, video-assisted support and documentation as well as video telephony.

	SMARC min/max	SMARC with Intel® Atom™ E3800 Series
Connector	314 pin	314 pin
Parallel LCD	0/1	0
LVDS	0/1	1
HDMI	0/1	1
DP	optional	optional
CAM	0/2	2
Par. CAM support	0/1	0
Ethernet	0/1	1
PCI Express®	0/3	3
USB 2.0	2/3	2
USB 3.0	0/2	1
SATA	0/3	1
AUDIO	0/1	1
I2S	1/3	1
SPI	2	2
SPDIF	0/1	0
I2C	4	4
SERIAL	2/4	3
CAN	0/2	0
GPIO	0/12+4	12
SDIO	1	1
SDMMC/EMMC	0/1	1

Figure 4: The SMARC interface specification for SoC-based Computer-on-Modules offers all the new interfaces required for 'Internet of Things'-connected embedded and intelligent devices such as SPI and a camera interface.

Available SMARC Computer-on-Modules

	SMARC-sXBTi (NEW)	SMARC-sAT30	SMARC-sA3874i	SMARC-sAMX6i
Processor	Intel® Atom™ E3800 Series	NVIDIA® Tegra® 3	TI Sitara AM3874	Freescale i.MX 6
Memory	Up to 8GB DDR3L	Up to 2 GB DDR3	Up to 2 GB DDR3	Up to 2 GB DDR3
Graphics	HDMI, LVDS	HDMI, LVDS	HDMI, LVDS	HDMI, LVDS
Onboard SSD	2-32 GB eMMC (SLC), 4-64 GB eMMC (MLC)	16GB NAND/eMMC FLASH	Up to 32GB NAND	Up to 64GB NAND/ eMMC
PCI Express®	3x PCIe Gen 2.0	1x PCIe Gen 1	1x PCIe Gen 1	3x PCIe Gen 1
SPI	2	2	-	2
USB 2.0 / 3.0	2 / 1	3 / -	2 / -	3 / -
Camera interfaces	2x CSI	2x CSI	-	1x CSI, 1x PCAM
Operating systems	Win8, WE8S, Win7, WES7, WEC7, Linux, Android, VxWorks	Android ICS, Linux	Windows WEC7, Android, Linux	Windows WEC7, Android, Linux
Temperature range	-40°C to +85°C	0°C to 60 °C	-40°C to +85°C	Up to -40°C to 85°C

About Kontron

Kontron is a global leader in embedded computing technology. With more than 40% of its employees in research and development, Kontron creates many of the standards that drive the world's embedded computing platforms. Kontron's product longevity, local engineering and support, and value-added services, helps create a sustainable and viable embedded solution for OEMs and system integrators.

Kontron works closely with its customers on their embedded application-ready platforms and custom solutions, enabling them to focus on their core competencies. The result is an accelerated time-to-market, reduced total-cost-of-ownership and an improved overall application with leading-edge, highly-reliable embedded technology.

Kontron is listed on the German TecDAX stock exchanges under the symbol "KBC". For more information, please visit: **www.kontron.com**

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