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Whitepaper

SMARC 2.0

Enter the next level of mobile-grade system designs

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www.adlinktech.com
2016

Distribuída no Brasil pela LRI | vendas@lri.com.br | 51 2129-3000

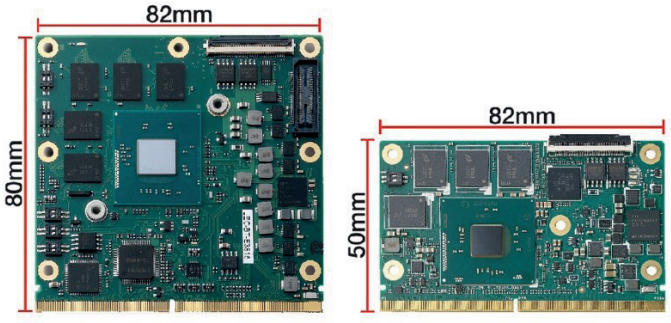
SMARC 2.0

The SMARC (Smart Mobility ARChitecture) standard specifies credit card-sized Computer-on-Modules (COMs) for highly compact, mobile systems. While such systems get deployed in a broad range of applications – from stationary or portable to outdoor and in-vehicle devices – they share some common features; these systems offer particularly small, flat and energy-saving designs that can be powered by solar cells and/or batteries. The new SMARC 2.0 specification by the Standardization Group for Embedded Technologies e.V. (SGET) takes mobile-grade system development to the next level. What are the new features and key improvements?

The SMARC standard – initiated by a consortium of major embedded computer vendors initiated by a consortium of embedded computer vendors, including ADLINK Technology as a major contributor – has firmly established itself as a prominent COM form factor since its initial presentation in 2011. Today, SMARC modules are supported by all leading vendors, and the vendor independent SGET that has been maintaining this standard since 2012 has grown to include 53 members. With the release of SMARC 2.0 in June 2016, the SGET takes mobile-grade system design to the next stage of interface technology without violating backward compatibility. It is expected that this new specification will gain even higher market acceptance with more vendors supporting and more OEMs using it. Thus it is worth having a closer look at what SMARC offers and what the game changing improvements are.

The basics

SMARC defines two different module sizes: a short format of 82mm x 50 mm and a full size format of 82mm x 80mm that provides more space for larger memory, as well as flash storage and other extensions on the module.



SMARC supports two sizes: full and short.

SMARC modules are characterized by a low profile, low power edge connector that can be plugged into the future-proof MXM 3.0 edge connector socket originally defined for use with MXM 3.0 graphics cards. Offering an extremely high I/O density on the only 82 mm wide connector, SMARC modules are perfectly positioned between Qseven and COM Express. With 314 pins, SMARC modules can provide more interfaces than the Qseven (230 pins) standard, and, compared to COM Express (440 pins), SMARC offers a reduced size, power and cost footprint.

The differentiator

In-line with the processor trend in the mobile-grade commercial sector, SMARC is also the first COM specification to have been designed from the outset for both leading processor architectures, ARM and x86, in this area. This is a huge difference compared to older module standards such as COM Express, which focuses only on x86. Consequently, all mobile-grade low and ultra-low power embedded SoCs are available on SMARC.

The evolution

Since 2011, the SoCs used for mobile-grade systems have seen gains in performance and energy efficiency unmatched by CPUs for fixed systems. Some of these improvements have been achieved through the support and integration of new interfaces. LCDs, for example, have become more or less obsolete, whereas higher display resolutions up to 4K are now standard and supported by the latest x86 processors even in the lower 5 Watt TDP range. Or take the camera interface; it has now transformed from parallel to serial CSI or USB bus. And for the stationary use of slim-line mobile-grade devices, the multiple display requirements have led to a need to offer more variants such as dual channel LVDS. SMARC has prepared for these changes by leaving some of the pins unspecified in the 1.1 revision. These pins are called Alternate Function Blocks (AFBs) and have in the past provided the flexibility to integrate features specific to the individual application. Now they are being used to make a smooth transition to the new 2.0 revision.

The next level

With the publication of the 2.0 specification, the latest interfaces of leading SoC platforms were integrated while maintaining compatibility with the 1.1 pinout to the widest possible extent. Only pins for interfaces that were barely used or looked likely to be replaced in the near future by more modern interfaces were allowed to be reassigned. Another goal was to ensure that a design would not be damaged if a 2.0 module was deployed by accident on a 1.1 carrier board or, vice versa, a 1.1 module mounted on a 2.0 carrier board. As long as any pinout changes are taken into account, SMARC 2.0 modules can be integrated into existing carrier boards, thereby extending the long-term availability of existing designs beyond the availability of SMARC 1.1 modules. Most of the key interfaces supported by 1.1 have not changed in 2.0; such interfaces include 1x SATA,

12x GPIO, 2x CAN bus, 1x SDIO (4bit), 4x UART, 1x HDMI, 1x SPI and 4x I2C. But what are the alterations and upgrades from SMARC 1.1 to SMARC 2.0 in detail?

Added in SMARC 2.0	Upgraded in SMARC 2.0	Unchanged	# Interfaces SMARC 2.0	Details	Removed in SMARC 2.0
				Display Interfaces	
LVDS/eDP/DSI			1	New in SMARC 2.0: Upgrade to dual channel LVDS, configurable also as eDP or MIPI DSI	
DP++			1	New for SMARC 2.0 modules: DisplayPort++	
	HDMI/DP++	HDMI/DP++	1	HDMI, now configurable as DP++	
			-	Removed in SMARC 2.0, previously primary display with 24 bit parallel RGB data, consuming 28 pins	**Parallel LCD**
				Camera Interfaces	
		CSI	2	Unchanged: One CSI 2 lane camera input and one CSI 4 lane input	
			-	Parallel camera support multiplexed with CSI and dedicated support signals removed in SMARC 2.0	**PCAM**
				Serial Interfaces	
	USB 2.0		6	Added in SMARC 2.0: 3x additional USB 2.0 ports, one is OTG (client or host); other ports host only	
USB 3.0			2	Added in SMARC 2.0: 3 2x USB Super Speed ports (USB 3.0), 1x OTG (client or host); **2nd port host only**	
				Audio Interfaces	
		HDA	1	Unchanged in SMARC 2.0: High Definition Audio	
		I2S	1	Reduced to one I2S port in SMARC 2.0	**1x I2S**
				SPDIF removed in SMARC 2.0	**SPDIF**
				Networking & data interfaces	
	GBE		2	Added second Gigabit Ethernet port	
	PCIe		4	In SMARC 2.0 added: 4th PCIe x 1 lane, legacy PCIe support signals omitted	
		SATA	1	Unchanged, support up to SATA Gen 3.0.	
		SDIO	1	Unchanged	
		SPI	2	2 ports (one of the two may be a boot device)	
eSPI			1	Added in SMARC 2.0: eSPI	
		I2C	4	Unchanged	
		Serial Ports	4	Unchanged	
		CAN	2	Unchanged	
		GPIO	12	Unchanged	
				eMMC removed in SMARC 2.0	eMMC

Table 1: The SMARC 2.0 upgrades.

More display interfaces

The most 'visible' change in SMARC 2.0 is support for three independent high resolution digital displays by adding DP++ (Dual-mode DisplayPort) to the feature set. This upgrade is driven by the increase in graphics capabilities and technologies of the latest SoCs. In particular, the new DP++ display interface has established itself as a common interface in the latest SoC platforms. DP++ supports resolutions up to Ultra HD/4K with 3840 × 2160 pixels. Another benefit of DP++ is its versatility, because DVI and HDMI displays can also easily be implemented by simply integrating an electrical signal level conversion from TMDS to LVDS.

Additionally, the previously single-channel LVDS in SMARC 1.1 has been extended to dual-channel LVDS in 2.0. This interface can now drive either two low-resolution or one high-resolution display. Depending on the integrated SoC, the interface can drive displays with a resolution of up to 1920 x 1200 pixels at 60Hz. Also added is the ability for the pins used for LVDS signals to be be multiplexed with signals for eDP or MIPI DSI.

The existing HDMI/DP interface remains unaltered. So existing carrier boards with single-channel LVDS and HDMI can be used with SMARC 2.0 just as before.

SMARC 2.0 Display Support		
Interface	**Configuration**	**Compatible to SMARC 1.1 carrier boards**
LVDS LCD	Default display, configurable as 18/24 bit single channel or 24 bit dual channel Possible also as eDP or MIPI DSI	Yes
HDMI / DP	Configurable as HDMI or DP	Yes
DP++	-	No

More and faster USB ports

The next big addition pertaining to the latest serial peripheral interfaces is increased USB support. The number of supported USB ports has increased significantly with SMARC 2.0, from three USB 2.0 ports (not counting AFB) now up to six High Speed 2.0 USB ports with a capacity of 480 Mbit/s. At least one USB 2.0 port is specified as mandatory. The first USB port can be configured as client, OTG or host, whereas the five remaining USB 2.0 ports are specified as hosts.

Additionally, version 2.0 allows two USB ports to be executed as SuperSpeed USB 3.0 interfaces, offering an impressive 4,000 Mbit/s transmission capacity each. This is particularly useful for high-bandwidth plug & play storage devices for media streaming applications, as well as high-speed cameras and special solutions such as frame grabbers or DSP cards for industrial applications.

SMARC 2.0 USB Support		
Interface	**Configuration**	**Compatible to SMARC 1.1 carrier boards**
USB 0	USB 2.0 client/OTG/host	Yes
USB 1	USB 2.0 host	Yes
USB 2	USB 2.0 host or USB 3.0 host	Yes / no
USB 3	USB 2.0 host or USB 3.0 client/OTG	Yes / no
USB 4	USB 2.0 host	no
USB 5	USB 2.0 host	no

More Gigabit Ethernet ports

The SMARC 2.0 specification also supports connected IoT devices with two Gigabit Ethernet (GbE) interface options instead of just one. This benefits many industrial devices that must connect multiple devices in the field. Now the Ethernet lines can simply be looped through. Installations can significantly reduce the amount of cabling by implementing line or ring topologies instead of star topologies. Native support of a second Ethernet interface is also a plus for IoT connected devices with integrated gateways and process computers with vertical integration, where one Ethernet port connects to the field and the other to the management level.
Another feature worth mentioning is the new IEE1588 trigger signal. It carries the precision time protocol to tightly synchronize several devices in a local network. This is important, for example, in time-critical IoT or industry 4.0 applications for real-time machine control.

SMARC 2.0 Ethernet Support		
Interface	**Configuration**	**Compatible to SMARC 1.1 carrier boards**
GBE 0	1st GBE	Yes
GBE 1	2nd GBE	No

More PCI Express lanes

In addition to these dedicated interfaces, designers benefit from a 33 percent bandwidth increase for the integration of individual function extensions on the carrier board by a fourth PCI Express (PCIe) lane. These can be additional computing cores like ASICs or FPGAs for the pre-processing of transducer data in portable medical ultrasound devices. Integrated IoT gateway designs can use them for up to eight additional GbE ports. Or designers can use them to execute a modular mPCIe slot on the board. This enables designers to implement any expansion available in this global standard, like wireless modems for WLAN or 3G/4G, as well as flash storage media, etc. Three of these PCIe lanes are backward compatible with SMARC 1.1.

More improvements

On the multimedia side, the new specification has now integrated one High Definition Audio (HDA) interface for digital audio streams with up to 2x 192 kHz with 32 bit or up to 8x 96 kHz with 32 bit for 7.1 high definition surround sound. HDA is very common in x86 SoCs. It offers particular advantages for integration, as HDA codecs provide greater standardization than I2S. But with continued support of one HDA and one I2S port, the flexibility and greater energy efficiency that this bus offers are not lost.
Last but not least, one of the two SPI buses has been upgraded and can now also be configured as an Enhanced Serial Peripheral Interface (eSPI), which is the successor to Intel's Low Pin Count Bus (LPC). SPI and eSPI are both useful for IoT applications where both buses are used for short distance communication with a broad range of sensors.

The jettisoned legacy

The extensive addition of more and new interfaces required repurposing pins from unused or obsolete interfaces. Significant gains have been achieved by using the 28 pins previously occupied by the legacy parallel LCD interface. These pins are still assigned to display connections, but now transfer DP++ and second channel LVDS signals. The 20 pins of the AFB are now assigned to the additional USB and the second GbE port. Since many SMARC products already integrate a flash boot medium on the module, the external eMMC/SD (8bit) interface was removed, freeing 11 signal lines. And the hardly used PCIe support signals provided six pins. In the development towards a purely serial concept, the parallel camera interface support has also been removed. The six dedicated pins previously required for PCAM support are now used for the additional GbE and CSI signaling. Lastly, in regard to digital audio, thefour4 pins for the third I2S port, as well as the two pins for the legacy electrical SPDIF interface, were also reassigned.

Conclusion

According to Technavio , the entire COM market is expected to have a CAGR close to 18 percent during the 2016-2020 forecast period. With this 2.0 upgrade, SMARC further strengthens its positioning in the COM market. It now offers an even richer feature set, a clear market position and reliable processor roadmap for designs in all the various mobile-grade markets – including any space-saving IoT devices and gateways, as well as extremely small and fanless graphics-oriented applications such digital signage, gaming and mobile medical devices. With CAN bus and up to four serial interfaces, it also offers the specific interfaces required in the industrial and transportation segment. And with the extended offer of generic interfaces, the market options are nearly unlimited. With this flexible, multi-functional feature set, SMARC looks to a bright future with high market acceptance and impressive CAGR over the next five years.

The first SMARC 2.0 module

The first new SMARC 2.0 module to be released by ADLINK Technology will be powered by the next generation of Intel® Atom , Intel® Celeron™ and Intel® Pentium™ processors (formerly codenamed Apollo Lake).



SMARC Intel® Atom™ E3900 Series LEC-AL module.

These new x86 SoCs support three digital displays and up to UHD/4K graphics resolution. On top of this, faster clock cycles will ensure faster data transmission. Possible applications for the upcoming SMARC 2.0 generation include mobile devices in industrial automation, medical technology and test and measurement, as well as digital signage and transportation.

The ADLINK advantage

To tailor its portfolio to all those different markets, ADLINK Technology builds its SMARC COMs with its proven Extreme Rugged technology, which enables all modules to operate within an extended temperature range of -40°C to +85°C by design. In combination with ADLINK Technology's SEMA (Smart Embedded Management Agent) Cloud® platform, which enables the remote monitoring and management of embedded SMARC platforms, ADLINK's SMARC modules are an excellent building block for connected devices in

the Industrial IoT segment. The centerpiece of every SEMA implementation is the Board Management Controller (BMC) on ADLINK modules that supports the SEMA functions. From here, the SEMA Extended EAPI provides access to all system functions. A web-based dashboard allows remote monitoring of one or more devices.

Service is the key

To accelerate and ease the implementation of SMARC modules, ADLINK also provides developers with local carrier board design support, for example, by supplying exemplary circuit diagrams along with measured values, as well as signal and power integrity simulations and measurements.



Custom-specific SMARC carrier board design with passive cooling.

In each of the three regions of the world, ADLINK Technology further provides comprehensive development resources for custom carrier board design services and, when required, also partners locally with various third party design houses that also offer SMARC carrier board design services. This enables OEMs anywhere in the world to quickly and efficiently obtain very individual modular platforms.
For further information, visit http://www.adlinktech.com/Computer-on-Module/SMARC

Source: https://en.wikipedia.org/wiki/DisplayPort
http://www.businesswire.com/news/home/20160607005664/en/Global-Computer-Module-Market-Post-CAGR-18

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