Extension MEDIA

Embedded Intel® Solutions

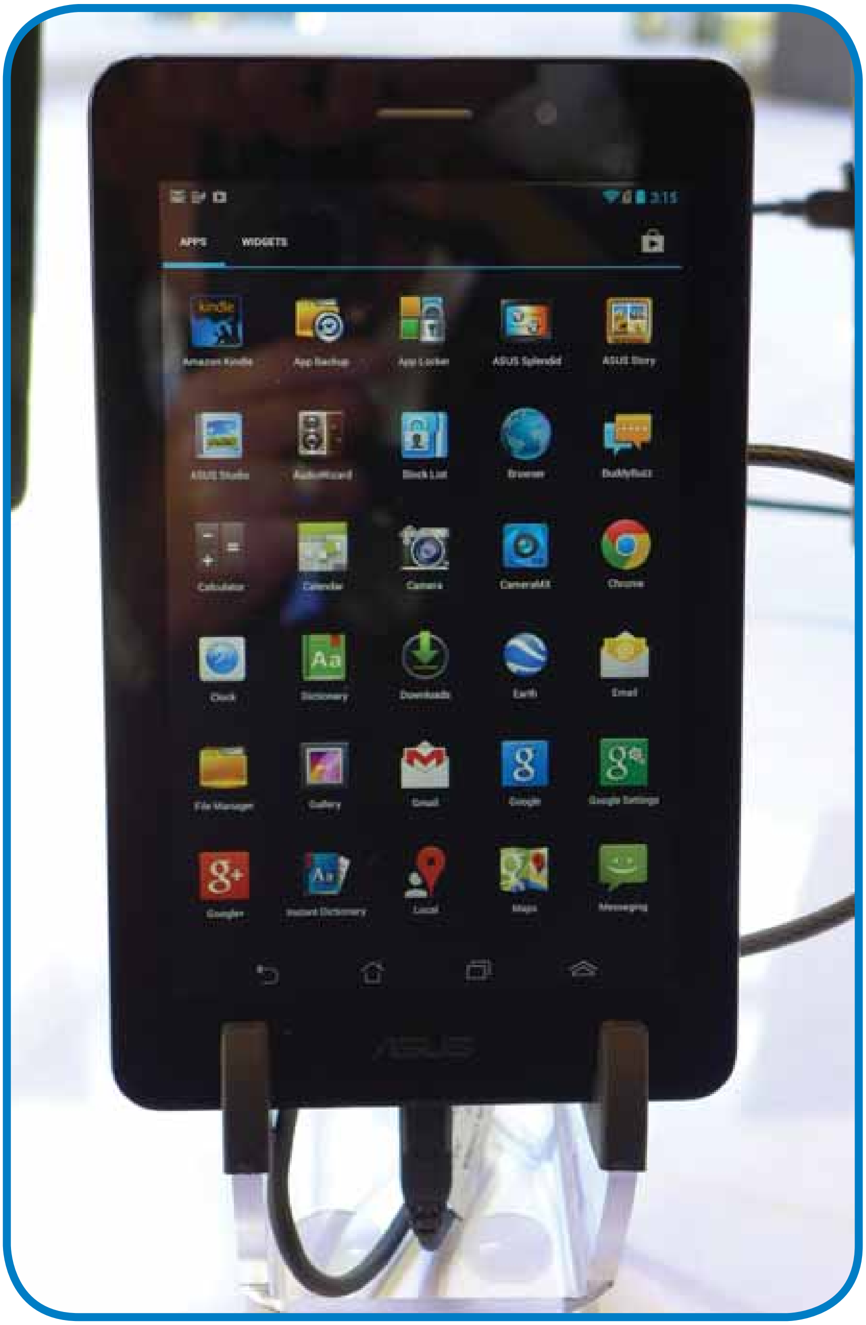
Summer 2014

Mobile and IoT Drive Embedded Small Form Factor Evolution

Development Options Evolve with Advances in Intel® Processor Performance-Per-Watt

Advanced Image Stabilization Techniques for Tablet Camera Performance

Meeting the Power Neutrality Challenge in Mobile Handsets



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System of Systems Spawns Essential "System of Suppliers"

Chris A. Ciufo, Editor-in-Chief

In October 2013, IDC forecast a whopping 212 billion "Things" on the Internet of Things — 30.1 billion of which are already installed and waiting to connect. These numbers point to an existing installed base of legacy devices and an urgent need for interoperable connectivity. Intel, at the core of the M2M >>> Intelligent Systems >>> Internet of Things trend, is working madly on many fronts to codify the IoT by catalyzing systems, software and supplier relationships.

The company, of course, wants to sell chips everywhere in the IoT: at the end-point nodes (things); interim sensor aggregator gateways; cloud and enterprise infrastructure; monitoring/host platforms; and analytics big data servers. Intel's efforts represent a huge, humongous task consistent with the huge, humongous revenue opportunity.

Consider Intel's in-process initiatives:

- **Tying legacy devices to the Internet will require gateways.** Existing sensors and platforms, such as streetlights or intersection pavement sensors, can't cost-effectively be retrofit for Internet connectivity. Instead, groups of sensors will be connected to Intel Gateway Solutions for the Internet of Things. The gateway will have analog and digital legacy I/O (such as RS-232/422 or TTL) that bridges to the Internet and adds local IoT intelligence.

  Intel has created a segment-specific family of gateway platforms and an array of industry partners including ADI, ADLINK, Advantech, Eurotech and Portwell. Examples: Intel's Moon Island is a demo platform based upon Quark x1000 SoCs or Atom E3800 CPUs, and Galileo is a Quark-based, Arduino shield-compatible HDK.

- **Interoperability will be assured through new Open Interconnect Consortium.** As we went to press, Intel helped form the OIC with Atmel, Broadcom, Dell, Samsung and Wind River. The consortium's work is to assure electrical connectivity and compatibility, as well as addressing protocol and communications. Although MQTT is a common basis for IoT device communication, other options, including Qualcomm's AllJoyn, exist. 30 billion devices need to talk the same language. Market-specific specs are forthcoming (www.openinterconnect.org).

- **Internet of Things Solutions Alliance.** The former vendor community called "Intelligent Systems" switched hats and doubled down to a much clearer mission that's now: "Bridging end-to-end for IoT." There are only five Premier members: ADLINK, Advantech, Dell, Kontron and Portwell. Coincidentally, each is focusing engineering efforts in complementary markets. ADLINK, for example, is targeting Industrial IoT with efforts like the company's SEMA cloud communications software and MXC-2300 fanless IoT gateway. (http://iotsolutionsalliance.intel.com)

I'm confident Intel will pull it off. The company's successes speak for themselves: low power laptops that ended the GHz race; Netbooks, UltraThin notebooks; and today's 2-in-1 tablet hybrids that are chipping Apple's hegemony.

Chris A. Ciufo is editor-in-chief for embedded content at Extension Media, which includes the EECatalog print and digital publications and website, Embedded Intel® Solutions, and other related blogs and embedded channels. He has 29 years of embedded technology experience, and has degrees in electrical engineering, and in materials science, emphasizing solid state physics. He can be reached at cciufo@extensionmedia.com.

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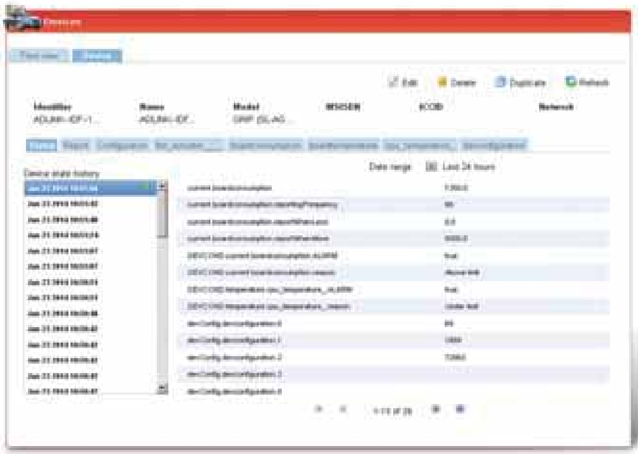
SEMA Cloud for Remote Device Management and Control

Device Monitoring and Control



- System status monitoring
- Secure remote access and device control

Analytics and Alert Management

- Policy-setting for multiple parameters
- Alert management and configuration

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SMARC COM Express PC/104 intel IoT Solutions Alliance

Embedded Intel® Solutions

SUMMER 2014

DEPARTMENTS

SPECIAL FEATURES

ON THE COVER: *A very early version (2013) of what's probably an ASUS MeMO Pad 7 Tablet running Android with an Intel Atom Bay Trail processor. (The tablet was spied at IDF 2013 by one of our editors.)*

TECHNOLOGY APPLICATIONS

MARKET WATCH

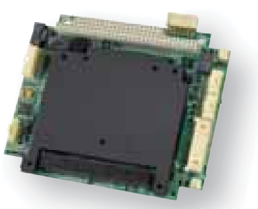
STANDARDS WATCH

LAST WORD

PRODUCT SHOWCASE

Intel® Atom™ Processor E3800 Series-based
Single Board Computers
Fanless -40° to +85°C Operation

Intel® Atom™ Processor E3800 Series-based
Industrial Computer Systems
Fanless -40° to +85°C Operation



Intel® Atom™ Processor-Based PC/104
Single Board Computers
Rugged, Stackable Form Factor

Single Board Computers
COM Express Solutions
Power Supplies
I/O Modules
Panel PCs

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COM Express®

conga-TS87

- 4th Generation Intel® Core™ processor-based platform
- 3x DisplayPort 1.2, up to 4k resolution (QFHD=3840x2160@60Hz)
- Intel® Advanced Vector Extension (Intel® AVX) 2.0 for improved floating point computing
- Up to 13% higher computing performance*
- Up to 32% higher 3D graphics performance*

* SPECint_base2006, 3DMARK Vantage

Formfactor	**Formfactor COM Express™ Basic, (95 x 125 mm), Type 6 Connector Layout**
CPU	Intel® Core™ i7-4700EQ processor (4x 2.4 GHz, TDP 47W) Intel® Core™ i5 processor planned Intel® Core™ i3 processor planned Intel® Celeron® processor planned Intel® Turbo Boost Technology, Intel® Hyper-Threading Technology (Intel® HT Technology), Intel® Advanced Vector Extensions 2.0 (Intel® AVX2), Intel® Advanced Encryption Standard New Instructions (Intel® AES-NI), Integrated dual channel memory controller, up to 25.6 GByte/sec. memory bandwidth, Intel® HD graphics with dynamic frequency up to 1GHz, Intel ® Clear Video HD Technology Intel® Virtualization Technology (Intel® VT), Intel® Trusted Execution Technology (Intel® TXT), Intel® Streaming SIMD Extensions 4.2 (Intel® SSE4.2), PCLMULQDQ Instruction, Intel® Secure Key, Intel® Transactional Synchronization Extensions (Intel® TSX)
DRAM	2 Sockets, SO-DIMM DDR3L@1.35V up to 1600MT/s and 16GByte
Chipset	Mobile Intel® 8 Series Chipset: Intel® QM87 / HM86 chipset @ planned Intel® Celeron® processor variants
Ethernet	Intel® Ethernet Connection I217-LM GbE LAN Controller with Intel® Active Management Technology (Intel® AMT) 9.0 support
I/O Interfaces	7x PCI Express™ GEN. 2.0 lanes, 1x PEG GEN 3.0 (8GT/s), 4x Serial ATA® with 6 Gb/s, 4x Serial ATA® with 3 Gb/s (AHCI) RAID 0/1/5/10 support, 2x ExpressCard®, 4x USB 3.0 (XHCI), 8x USB 2.0 (EHCI), LPC bus, I²C bus (fast mode, 400 kHz, multi-master)
Sound	Digital High Definition Audio Interface with support for multiple audio codecs
Graphics	Next Generation Intel® HD Graphics with OpenCL 1.2, OpenGL 4.0 and DirectX11.1 support; up to three independent displays: HDMI 1.4, DVI, DP, VGA; High performance hardware MPEG-2 decoding, WMV9 (VC-1) and H.264 (AVC) support Blu-ray support @ 40 MBit/s
LVDS	Dual channel LVDS transmitter, Supports flat panels 2x24 Bit interface, VESA mappings, resolutions up to 1920x1200, Automatic Panel Detection via EDID/EPI
Digital Display Interface (DDI)	3x DisplayPort 1.2a / TMDS (DVI, HDMI)
CRT Interface	350 MHz RAMDAC, resolutions up to QXGA (2048x1536 @75Hz)
congatec Board Controller	Multi Stage Watchdog, non-volatile User Data Storage, Manufacturing and Board Information, Board Statistics, BIOS Setup Data Backup, I²C bus (fast mode, 400 kHz, multi-master), Power Loss Control
Embedded BIOS Features	AMI Aptio® UEFI 2.x firmware, 8 MByte serial SPI firmware flash
Security	The conga-TS87 can be optionally equipped with a discrete "Trusted Platform Module" (TPM). It is capable of calculating efficient hash and RSA algorithms with key lengths up to 2,048 bits and includes a real random number generator. Security sensitive applications such as gaming and e commerce will benefit also with improved authentication, integrity and confidence levels.
Power Management	ACPI 4.0 with battery support
Operating Systems	Microsoft® Windows 8, Microsoft® Windows 7, Linux, Microsoft® Windows® embedded Standard
Power Consumption	Typ. application: tbd., see manual for full details, CMOS Battery Backup
Temperature:	Operating: 0 .. +60°C Storage: -20 .. +80°C
Humidity Operating:	Operating: 10 - 90% r. H. non cond. Storage: 5 - 95% r. H. non cond.
Size	95 x 125 mm (3.74" x 4.92")

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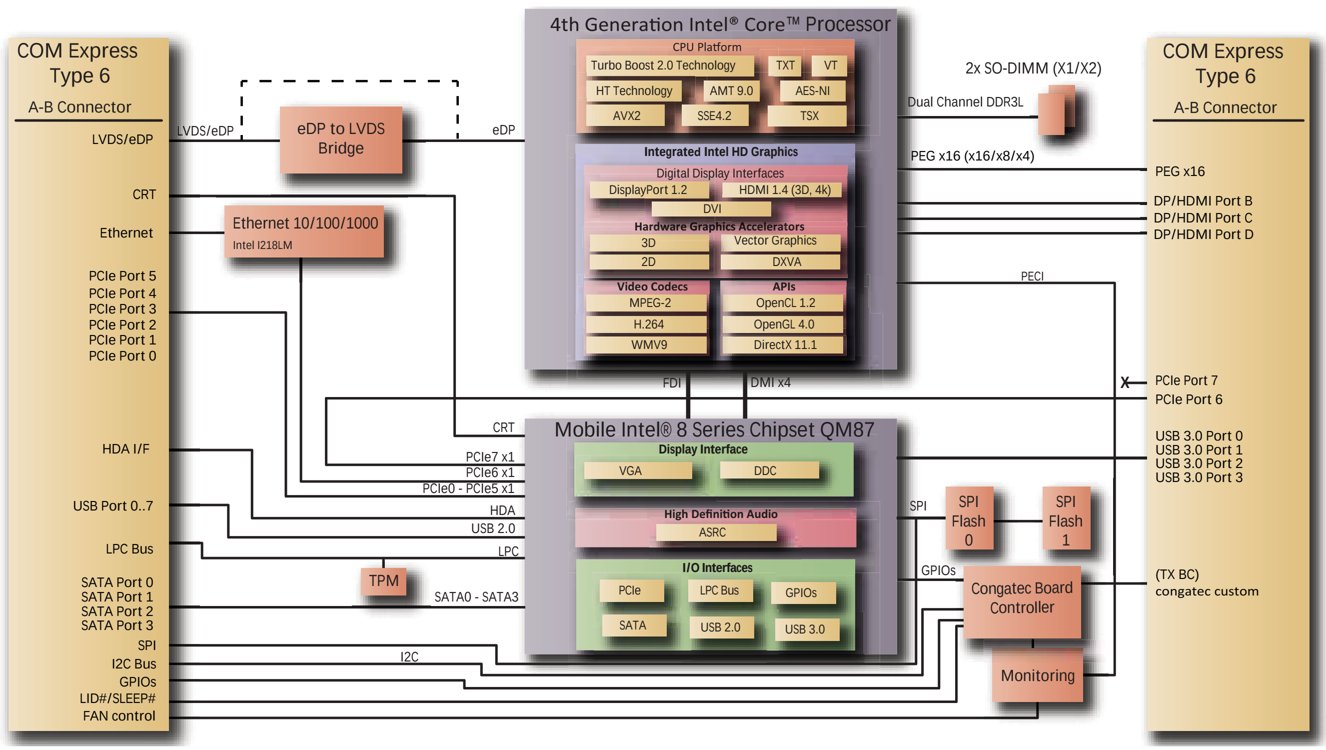

Article	PN	Description
conga-TS87/i7-4700EQ	046804	COM Express Type 6 Basic module with quad-core Intel® Core™ i7-4700EQ processor with 2.4GHz, 6MB L2 cache and 1600MT/s dual channel DDR3 memory interface
DDR3-SODIMM-1600 (2GB)	068767	DDR3 SODIMM memory module with 1600 MT/s (PC3-12800) and 2GB RAM
DDR3-SODIMM-1600 (4GB)	068770	DDR3 SODIMM memory module with 1600 MT/s (PC3-12800) and 4GB RAM
DDR3-SODIMM-1600 (8GB)	068780	DDR3 SODIMM memory module with 1600 MT/s (PC3-12800) and 8GB RAM

Engineering Tools / Accessories		
conga-TEVAL	065800	Evaluation carrier board for Type 6 COM-Express-modules
conga-LDVI/EPI	011115	LVDS to DVI converter board for digital flat panels with onboard EEPROM
COM-Express-carrierboard-Socket-5	400007	Connector for COM-Express carrier boards, height 5mm, packing unit 4 pieces
COM-Express-carrierboard-Socket-8	400004	Connector for COM-Express carrier boards, height 8mm, packing unit 4 pieces

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Development Options Evolve with Advances in Intel® Processor Performance-Per-Watt

The latest Intel® processors bridge a performance-power-cost gap to open a range of new low-power and small form factor embedded design strategies for IoT, industrial, healthcare, smart energy and transportation applications.

By Jeff Munch, ADLINK Technology

The Internet of Things (IoT) is fueling change by transforming isolated systems into smart, connected networks. Low-power performance is essential to this equation, enabling compact, sophisticated devices with outstanding thermal characteristics. Improvements in power consumption are expanding possibilities, and developers now have access to a credible option for low-power Intel® processor-based designs in a very small footprint. The latest Intel® Atom™ processor E3800 and Intel® Celeron® processor N2930 and J1900 product families, codenamed Bay Trail, bridge a performance-power-cost gap in the Intel® processor families and open a range of new embedded design strategies.

Industry Impact of Low-Power Improvements

Understanding the power efficiencies of the Intel® Atom™ processor E3800 product family is essential to understanding the IoT opportunity. The shift from isolated systems to connected intelligent platforms requires not only performance and connectivity, but also the creative design of smaller, rugged edge devices. Characteristics of the E3800 product family are specifically suited to these demands, and the series is purpose-built to enable design innovation in high-performance, small form factor (SFF) intelligent systems.

In this new era of connected computing technology, intelligent systems add global value as standalone systems evolve from their foundation in machine-to-machine (M2M) concepts to network and communicate with each other and the cloud. OEMs and developers can anticipate a convergence of increasingly connected devices, answering demand for real-time data gathering and sharing, nonstop communication, new services, enhanced productivity and more. Systems will solve business problems by being smart and connected, which is becoming a priority, adding business value such as cloud economics for compute and data operations.

(Intel® Atom™ processor E3800)

Figure 1. Silvermont microarchitecture represents the first top-to-bottom redesign of low-power Intel® Atom™ processors, slated first in a family of cores that Intel states will be refreshed every year for the next few years. Where the previous 32nm microarchitecture was a derivative of 45nm process technology, Silvermont microarchitecture represents an entirely new design re-architected from the ground up.

As IoT strategies unfold—for example in healthcare, smart metering, POS and retail banking, factory floor systems and connected buildings—the business case for intelligent services increases. Minimal power consumption is a primary driver in this renaissance. Low-power designs using the Intel Atom processor E3800 product family support mobile or portable devices, but more importantly, capitalize on thermal characteristics to manage fully enclosed, passively cooled designs as the key to enabling connectivity anywhere.

Redefining the Low-Power Landscape

To capitalize on this promise of the Internet of Things, innovative embedded designs must not only be high-performance but also power-sensitive, assuring they can be deployed in the broadest spectrum of computing environments. Low-power computing is at the heart of this requirement, enabling small, high-performance systems that inherently require more stringent thermal characteristics. Where low-power architectures for smartphones and tablets have increased visibility of energy-efficient consumer devices, a similar shift is evident in connected embedded arenas.

The x86 evolution continues, with Intel answering low-power needs with smaller, more efficient Intel Atom processors. The E3800 product family is a system-on-chip (SoC) developed for intelligent systems—embedded systems that are designed to be smarter, securely collecting and sharing sensor data to enable new applications or user experiences. These SoCs are optimized for systems that require efficient imaging workflows, delivery of secure content and interactive, real-time processes—supporting OEMs and developers as connected embedded applications grow in demand and functionality.

Scalable Low-Power Performance

The E3800 series closes a gap in power and performance—offering more horsepower than earlier Intel Atom processors—and touching the performance of entry-level Intel® Core™ processors. Efficiency is improved over earlier generations of Intel Atom processors, and thermal design power (TDP) and footprint are smaller than Intel Core processors. In addition to featuring 22nm process technology, new Silvermont microarchitecture (See Figure 1) and more efficient cores, these small, efficient Intel Atom processors integrate faster graphics and a built-in security engine on a chip that draws less than 10 watts of power; the resulting low-power profile is ideal for the non-stop performance demands of intelligent systems.

The Intel® Atom™ processor E3800 product family incorporates sophisticated power-management capabilities, such as very low power consumption for embedded systems that spend significant time in sleep states.

The Intel Atom processor E3800 product family features multiple SKUs with pin-compatible single-, dual- and quad-core offerings. These SoCs can handle both single-threaded and multi-threaded processing when more complex computing tasks are required. In addition to being capable of handling larger and more demanding processing jobs via multi-threading, good scaling speed improves processing efficiency; this is essential for the range of real-time data streams coming from sensors, communications or video applications common to connected embedded applications. When applications are ready for next-generation, low-power performance, Intel Atom processor E3800 product family-based designs are easily scalable to Intel Core processors within the same architecture.

Fine-Grained Power Management

The Intel Atom processor E3800 product family incorporates sophisticated power-management capabilities, such as very low power consumption for embedded systems that spend significant time in sleep states, such as printers or ATMs. These processors assign the total SoC energy budget dynamically according to application needs; this supports dynamic power sharing between the CPU and graphics, which allows for higher peak frequencies.

Intel® Burst Technology 2.0 support for single- and multi-core also offers a high degree of responsiveness scaled for power efficiency. With intelligent burst technology, the system can tap an extra core when necessary, which allows CPU-intensive applications to run faster and smoother. What's more, 2MB of L2 cache assures the device operates faster and more responsively when running multiple applications and services at the same time.

Applying Intel® Atom™ Processor E3800 Product Family Improvements to Connected Embedded

The SoC design of the Intel Atom processor E3800 product family reduces bill of materials (BOM), offering a cost advantage in tandem with power and performance gains. In addition to BOM savings, a one-chip solution allows for smaller form factor solutions over earlier generation, two-chip offerings. In certain cases, such as multifunction printers or ultrasound machines, the SoC even eliminates the need for development of custom ASICs/FPGAs to perform imaging functions. Further, a single die on a single package delivers the high levels of integration needed for intelligent system designs, such as efficient and dedicated image signal processing.

Integration of I/O interfaces is outstanding—supporting display interfaces with graphics processing, camera interfaces with image processing, audio with digital signal processing (DSP), multiple storage types and legacy embedded I/O. Expansion capabilities are readily available through industry-standard high-bandwidth interfaces such as PCI Express Gen 2.0, Hi-Speed USB 2.0 and USB 3.0 connectivity.

The E3800 product family also performs to within industrial temperature extremes (See Figure 2), with a Tjunction range from -40° C to 110° C. This feature allows for passively cooled, light solutions that must exist in extreme environments, such as either hot or cold.

Security and Graphics Improvements Add Design Value

Advancements in visual-processing capabilities are relative to previous-generation Intel Atom processors, and enable faster media conversions, stereoscopic 3D, immersive web browsing and enhanced HD video transcoding with Gen 7 graphics and highly efficient image processing. For example, the Intel Atom processor E3800 product family graphics are strong enough to accommodate a modern OS with a graphical user interface for Blu-ray playback, as well as throughput appropriate for demanding applications such as complex 3D drawings and gaming.

Security is also of essential importance in connected embedded designs, and built-in security features of the Intel Atom processor E3800 product family can be considered a competitive factor in these applications. For security enhancement and content protection, it incorporates Intel® Advanced Encryption Standard New Instruction (Intel® AES-NI), hardware-assisted encryption instructions to enable faster data encryption and decryption. Secure endpoints protect sensitive content and allow only chosen software to run on the device. Data is secured as it moves through the network, and is encrypted up to four times faster than earlier generations. Overall, encryption and decryption performance improves when executed in hardware, in contrast to using software algorithms, which can be costly in terms of cycling and power consumption.

Product Family	Brand	Processor No	TDP (W)	Junction Temp range (°C)
Bay Trail-I	Intel® Atom™	E3845	10	-40 to 110
		E3827	8	-40 to 110
		E3826	7	-40 to 110
		E3825	6	-40 to 110
		E3815	5	-40 to 110
Bay Trail-M	Intel® Pentium®	N3520	7.5	0 to 105
		N2920	7.5	0 to 105
		N2820	7.5	0 to 105
		N2806	4.5	0 to 105
		N2815	7.5	0 to 105
Bay Trail-D	Intel® Pentium®	J2900	10	0 to 105
	Intel® Celeron®	J1900	10	0 to 105
		J1800	10	0 to 105

Intel® Atom™ Processor E3800 ProductFamily of SoCs TDP performance. Source: Intel®

Figure 2. Low-power value adds design value for battery-operated devices, yet is even more relevant to enabling passively cooled systems with no forced airflow, deployable in the broadest range of rigorous embedded arenas.

Design Choices in Context

In the embedded realm, determining a design path requires consideration of a broad range of values. Designing with Intel processors has developers evaluating price, processor performance and power, but also software development and I/O requirements, ecosystem constraints and overall ease of development.

> ***The ARM environment is more complex and differentiated, with a singular focus on products typically optimized for a particular application.***

Software is often the most challenging part of system design. Familiar Intel processor environments are supported by development tools that help to implement, debug and fine-tune software. Performance is assured while time-to-market is reduced. Pinouts and I/O interfaces are also well-established for Intel processors, as Intel has been instrumental in defining not just the core microprocessor and instruction-set architecture, but also the architecture of peripherals. Embedded computing products based on Intel processors have capitalized on that chip-level expertise by providing either proprietary or open-standard products using common I/O interfaces. Common connector pinouts enable the widest range of hardware- and software-compatible peripherals for use in customizing end-user products.

The ARM environment is more complex and differentiated, with a singular focus on products typically optimized for a particular application. With less historical focus on building standard I/O definitions, each SoC would be used on a custom board design; also, depending on the target market, I/O options do not emphasize standard buses such as PCI Express. The resulting ARM marketplace includes a number of proprietary form factors and connector definitions that may lock designs to a single vendor and that may not support more than a single generation of silicon even as designs move to more advanced SoCs.

Low Power Enables Embedded Innovation

Embedded evolution marches on, and developers now have access to a credible option for low-power Intel processor designs in a very small footprint. The Intel Atom processor E3800 product family can help designers balance power and performance, while still developing the high-compute solutions for which Intel processors are known. Developed to enable high performance, small form factor intelligent systems, the E3800 product family addresses a specific power-performance need—blending media and compute performance, low TDP and reduced BOM in a low-power SoC. OEMs and developers are capitalizing on these characteristics to advance the Internet of Things; embedded connected solutions now encompass lightweight, passively cooled solutions supported by a known and trusted software toolchain and next-generation scalability to Intel Core processors.

Figure 3. ADLINK Technology is enabling the Internet of Things with innovative embedded computing solutions for industrial automation, communications, medical, defense, transportation and infotainment industries. Our Intel® Atom™ processor E3800-based products include SMARC® computer-on-modules to power edge devices, the MXE-200i IoT gateway for connectivity and data transfer, and our SEMA (Smart Embedded Management Agent) Cloud Services for access to system data from anywhere, at anytime.

The Intel Atom processor E3800 product family offers more computational power than its predecessor, and is able to fit the thermal envelope required for applications with temperature and airflow constraints, for example, passive cooling with no forced airflow and +80°C ambient air. As connected embedded requirements continue to expand—for instance onboard train management and wayside control systems, remote video surveillance and monitoring, factory automation such as pick-and-place and 3D robotics—designers have a greater range of Intel processor options to develop competitive designs that quickly get to market.

As ADLINK CTO, Jeff Munch heads all R&D operations in North America and Asia and is responsible for building ADLINK's presence throughout the world. Munch has over 20 years of experience in hardware design, software development, and engineering resource management. Before joining the company, he spent five years at Motorola Computer Group as director of engineering. Munch is Chair of several PICMG Subcommittees and brings a wealth of technical knowledge and experience to ADLINK's management team.

IoT Standards Enable Interoperability

Experts weigh in on challenges in IoT device development, the value of standards, and the importance of standards groups such as the Industrial Internet Consortium.

By Kenton Williston, Intel® Internet of Things Alliance

The Internet of Things (IoT) promises a future where everything is online. But today, a lack of standards makes it difficult to connect. To learn how developers can solve this problem, I spoke with three industry experts:

Jens Wiegand, CTO of Kontron

Ido Sarig, vice president and general manager of IoT Solutions Group at Wind River

Tony Magallanez, OEM systems engineer at McAfee

Below are key excerpts from my interviews.

Kenton Williston: What are the biggest challenges to deploying IoT solutions?

Jens Wiegand, Kontron: Currently the market is fragmented and characterized by incompatible systems and stovepiped solutions. IoT concepts like predictive maintenance, big data and analytics require a holistic approach, but there is a lack of cooperation between hardware and software suppliers, service providers and communication infrastructure vendors.

Ido Sarig, Wind River: Much of the industry's effort is focused on connecting legacy or "brownfield" devices that were not designed to be connected and even designed to make connectivity difficult in order to protect them from network-borne threats. Developers must figure out not only how to connect brownfield devices but how to safely connect them.

Another challenge is the lack of a single standard for connecting to networks. Many brownfield devices use proprietary protocols and will require gateways to connect with IP-based networks. And if they are already IP-based, they may be using a wide variety of protocols. Developers will need to be able to build gateways that support virtually any communication protocol.

Tony Magallanez, McAfee: The major problem we see is the security of these devices. These devices tend to be not manned but often handle personally identifiable information. The question is how you protect the data both while it's on the system and while it's being transmitted between devices.

KW: How can developers address these issues? In particular, how do standards and multi-vendor solutions help?

Wiegand, Kontron: Developers should strive to build on solutions that adhere to industry standards on all levels, from communications protocols to cloud connectors. In particular, they should seek standards that are supported by multiple industry leaders in the form of application-ready concepts. Such standards can reduce complexity and risk, and provide a time-to-market advantage.

Virtually every known type of hardware and software security measure comes into play in IoT.

Sarig, Wind River: Delivering secure and reliable IoT solutions requires an end-to-end view that encompasses the endpoint device, the connectivity layer, the gateway and the application running in the cloud. For example, security challenges need to be factored in at every level. Virtually every known type of hardware and software security measure comes into play in IoT. Secure booting at the device level, access control and authentication, application whitelisting and firewalls and intrusion prevention systems are just some of the tools at hand to respond to security threats.

The benefits of the IoT have been thus far constrained by the complexity of issues like this. As standards coalesce, market needs and business cases become more sharply defined, and operators and device manufacturers are freed to focus on the true value they can deliver: innovative new services and applications.

KW: What role do you see for standards bodies like the new Industrial Internet Consortium (IIC) (http://www.iiconsortium.org)?

Wiegand, Kontron: The IIC as well as Industry 4.0 (http://en.wikipedia.org/wiki/Industry_4.0) are good examples where a consortium of industry leaders drives towards a common goal: enabling business value for end customers by implementing standards and by developing the ecosystem to enable solutions.

Sarig, Wind River: Organizations such as the IIC bring together expertise and the tools to bring smart connectivity, high security and manageability to the market. These consortia will help expedite the realization of the IoT through specialized skills and expertise required to build intelligent devices which typically reside outside the core competency of operators and device manufacturers.

Magallanez, McAfee: Most people understand that they need security, but in many cases they lack expertise—and in far too many cases they end up doing nothing if they don't have to. That's where I see consortiums or standards-based organizations driving security.

Talking specifically about IIC, its recommendations are likely to overlap with the North American Electric Reliability Corporation Critical Infrastructure Protection (NERC CIP—http://www.nerc.com/pa/Stand/Pages/CIPStandards.aspx) recommendations. But one of the great things about these consortiums is that they go further than the regulations require. For example, they may recommend things like application whitelisting. In the regulatory bodies, whitelisting is still a bit of an outlying technology. So these standards bodies can help developers not only achieve compliance but also true security.

Many brownfield devices use proprietary protocols and will require gateways to connect with IP-based networks.

So how do you comply with these regulations? Typically, OEMs or ODMS have taken a buy or build mentality. However, it's very difficult to build your own security infrastructure. So it's wise to get help from vendors who are experts in security, and ask these security solution vendors to make sure the systems are secure.

KW: What role do you see for ecosystems like the Intel® IoT Solutions Alliance (http://iotsolutionsalliance.intel.com)?

Wiegand, Kontron: The Alliance is a great example of a large-scale ecosystem that enables rapid deployment with IoT solutions that are pre-integrated, verified and validated by system integrators and solution providers like Kontron. The benefits for our customers are flexibility, choice, velocity and the ability to focus on the development of innovative applications with less risk and pain.

Magallanez, McAfee: Alliance members will help provide the components to meet regulatory recommendations or requirements. They will give you the building blocks to get you to compliance and beyond. Without these groups, you will have different OEMs/ODMs and device owners all struggling to define what the security should look like. Not being security experts, they can miss out on some of the security opportunities.

KW: How you are using standards and ecosystem collaboration to create IoT solutions?

Sarig, Wind River: As part of Intel IoT Group, Wind River is collaborating with Intel on solutions like the Intel® Gateway Solutions for the Internet of Things (http://www.intel.com/content/www/us/en/internet-of-things/gateway-solutions.html), which serves as the software backbone for intelligent gateways. It is a complete software development environment that provides pre-integrated and fully tested ready-to-use components to secure, manage and connect intelligent gateways.

Magallanez, McAfee: What we are doing with the Intel Gateway Solutions for the IoT is providing a platform that will allow OEMs/ODMs to establish a base level of security and functionality in the device without having to do a lot of the development on their own. In addition, the hardware that's built in gives them a starting point that is easier than taking a huge SKU sheet and picking out the components individually.

Wiegand, Kontron: The Intel Gateway Solutions for the IoT is a good example of how Kontron builds on industry standards and capitalizes on the work of the Alliance by leveraging platform concepts to create IoT-enabled hardware and software stacks. [Editor's note: Kontron recently announced the Intel® Gateway Solutions for the IoT-based KBox A-201 mini.] But even more, we strive to develop standards further, grow the ecosystem and offer more value to our customers with IoT solutions that enhance the reach of our application-ready platforms. We see solution- and application-readiness as well as software expertise as key differentiators and innovation enablers.

This article first appeared in the Intel® Embedded Community (http://embedded.communities.intel.com/community/en), published by the Intel® Internet of Things Alliance.

Kenton Williston is editor-in-chief of the Embedded Innovator magazine, a publication of the Intel® Internet of Things Solutions Alliance (Intel® IoT Solutions Alliance). He is also a regular blogger for the Intel® Embedded Community, and contributes to several other publications as an Intel contractor.

Small Form Factors—One Size Does NOT Fit All

Aerospace and transportation applications are particularly affected by operating environments that are at the upper limits of most SFF standards, but even low-volume designs can benefit from modified, off-the-shelf building blocks.

By Patrick Dietrich, Connect Tech, Inc.

In today's world of embedded computing there is one thing that is not in short supply—design challenges! System developers would love to be able to pull building blocks off the shelf and put together a tightly integrated computing platform that is reliable and cost-effective. Fortunately there are many good choices but each must be considered carefully to be sure the requirements of your application are properly met.

Connecting and Cabling Challenges

Putting aside the common challenge of more performance at a lower cost, the next biggest challenges center on connecting and cabling within an embedded computing platform.

It is possible to build a system from any of several popular small form factor standards. We might design this system based on . . .

- COM Express
- miniPCIe
- PC/104
- SMARC
- mSATA
- MXM video
- Qseven

. . . but one size does not fit all and connecting these to the outside world can be a challenge.

Initially it may be all well and good to make a large motherboard with industry-standard connectors, but as we know, this is not an ideal fit in most embedded applications that have space and operating environment restrictions. To point out an example, let's compare two common carrier board approaches: one that uses standard PC-style connectors and one that uses locking, rugged pin headers.

The first approach has the advantage of using standard connectors (USB, Ethernet, serial, video) on the carrier to interface to various I/O devices in the system. These are readily available connectors that serve the purpose well if the environment is relatively benign. In this case, the mating cables are common, being available from a wide range of suppliers in all types of lengths and configurations.

The second approach uses locking, rugged pin headers for more durability. This carrier is ideal for space-constrained applications, harsh environments, demanding conditions and supports extended temperature ranges. But in this case, the cables are not as common or readily available; cables are usually custom-designed by the system designers. Cabling cost trade-offs must be made that are often driven by the specific use case.

Delving deeper into the interconnect challenges, it becomes even more complicated. Besides the I/O connections, there are board-to-board, board-to-I/O panel, and environmental and performance concerns to be addressed.

Board-to-board interfaces that enable mating of different styles of small form factor boards are sometimes needed. Embedded platforms may use multiple form factors either because of functionality only available in a specific form factor or to preserve legacy subsystems that are too costly or time-consuming to replace. The solution is to develop custom interpreters or "backplanes" that allow the differing form factors to be mated. Custom boards with connectors that are compatible with form factor A on one side and form factor B on the other have traces that route the signals to the proper places. These are not always the best choice, but in extreme cases they can be the only way to effectively address the mating problem. Occasionally, a cable connection may be required between mating boards to make the proper connections.

Figure 1: Connect Tech's CCG008 COM Express® Type 6 Ultra Lite Carrier Board uses standard PC-style connectors for interfaces such as USB, Ethernet, serial and video.

Board to I/O panel can create a tangle of cables within the enclosure.

Figure 2: Connect Tech's CCG011COM Express® Type 6 Rugged Ultra Lite Carrier Board uses locking, rugged pin headers and supports extended temperature ranges of -40°C to +85°C.

It is great when the enclosure matches the board form factor but that is not always possible or within the definition of the form factor specification. Small form factor motherboards are better at mating up with a defined area within an enclosure but stackable form factors don't have the luxury of industry enclosures that match the board I/O—leading to a cabling challenge.

Connector locking and mating height becomes increasingly important as the board form factor becomes smaller. Limited space prevents more traditional locking schemes. Finding suitable connectors that meet both the locking requirement demand by rugged applications and the height restrictions of the small form factor can be very difficult to overcome. Add to that the fact that many of the more common applications are very low volume so the connector suppliers have little incentive to solve the problems. It takes some serious effort to find connectors that can be used reliably and cost effectively.

High-speed signaling is the elephant in the room. There is no denying that signals will continue to increase in speed. Basic and simple non-impedance-controlled connector technology is already struggling to keep up. Active cables are emerging to help ease some of the performance issues, but they are expensive and usually custom at this early stage of the market. Custom cable harnesses are used to get around some of the problems. Even emerging new standards such as USB 3.0 present challenges. We have invested significant engineering time into finding a sound way to use low-profile locking pin header connectors for USB 3.0 and maintain signal integrity.

Module	Connection Scheme
COM Express	Header to carrier
mSATA	Edge connector
miniPCIe	Edge connector
MXM video	Edge connector
PC/104	Header to carrier, stackable
Qseven	Edge connector
SMARC	Edge connector

In all cases, the carrier can contain more rugged types of connectors for external I/O. It is not limited to traditional connectors such as USB, Ethernet and video.

Application Impact

Each application has its own set of restrictions and is thus impacted differently by the challenges we have discussed. Two application areas that are impacted the greatest are aerospace and transportation. Both of these have operating environments that are at the upper limits of most small form factor standards. Each uses embedded computing systems that are usually deployed in critical systems where failure is not a good option. And both typically have performance demands that are above average. All of this leads to even more of a challenge for the interconnection solutions.

Form Factor Specifics

Many of the commercially available small form factor products are computers-on-modules, putting the burden of the I/O connections on the carrier. The carrier can be designed to use very common I/O solutions such as those found on the most popular motherboard platforms. They can also be custom modified to meet the very specific requirements of the application.

Summary

In the vast and ever-growing world of small form factors, how does one determine what form factor is best for their design? At the end of the day the form factor needs to best support the customer's requirements with respect to space restraints, power requirements, thermal needs, feature set, cost—and don't forget about life cycle.

We see a growing need for customers to select from commercial off-the-shelf components as a complete, from-the-ground-up custom design cannot always be part of the equation. Without a doubt there is a mindset regarding computers-on-module in which many consumers believe this means "custom" carrier. We believe this should not be the case and simply can't be the case for those in smaller volume brackets. Off-the-shelf base boards are readily available and can be easily modified for a better fit when custom isn't an option.

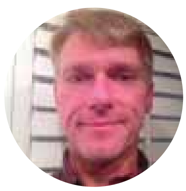
Patrick Dietrich is the Embedded R&D Lead at Connect Tech, Inc. Patrick has many years of experience as a lead designer and project manager on numerous FPGA, PCI Express and embedded COM carrier products developed by Connect Tech. Patrick received a bachelor's of science degree in systems and computing engineering from the University of Guelph in Canada. He is an IEEE member, a Licensed Professional Engineer, and an active member of the PC/104 Consortium's Technical Committee.

What's Up Next in the IoT?

The Internet of things shares many of the same challenges as human-Internet interactions, including the need for connectivity standards, improved security, and new power innovations—but there are twists.

By Cheryl Coupé, Contributing Editor

Kevin Kitagawa, Imagination Technologies



Jeff Fortin, Wind River

Adam Burns, Intel

Our Internet of Things roundtable is a deeply insightful look at the rapid changes—both in technology and business models—that this growing phenomenon is driving. I'm especially excited about our panel's thoughts on what the next big breakthroughs will be, and what impacts we can expect. Many thanks to Kevin Kitagawa, director of strategic marketing, Imagination Technologies; Jeff Fortin, director of product management, Wind River; and Adam Burns, product marketing director, IoT Gateways, IoT Solutions Group, Intel for participating.

The industrial IoT lives in a world where safety goes hand-in-hand with security.

EECatalog: What still has to happen in terms of standards to support the breathless growth forecasts for the Internet of Things (IoT)?

Kevin Kitagawa, Imagination Technologies: In order for IoT to really take off in the huge volumes predicted by analysts, standardization is a must in areas from device-to-device communication, data analytics, better low-power connectivity and protocols and even operating environments for IoT devices. We are seeing progress in several areas. The AllSeen Alliance has been formed to create a universal development framework to address some of these areas and remove roadblocks to IoT adoption. Collectively as an industry, we can create standards, overcome other challenges and advance IoT adoption.

Jeff Fortin, Wind River: The sheer magnitude of the Internet of Things, along with the introduction of unattended devices (devices with no or limited human interaction), have presented challenges to nearly all existing standards for connectivity, management and security. Standards need to evolve to account for the non-homogeneous nature of IoT. Systems that were not designed to communicate with each other are being connected through IoT gateways which has the potential for increasing security vulnerabilities. In addition, data semantics may not be compatible between systems, leading to costly data- or protocol-conversion processing in order to normalize the data for use by analytic software in the datacenter. Standards leadership is needed to understand how we can combine standalone systems into systems-of-systems in a secure and cost effective way in order to foster the faster innovation promise of the IoT.

Adam Burns, Intel: The industrial Internet of Things (IoT) encompasses a wide range of use cases where the majority includes legacy infrastructure and sensors. The wide variety of sensor/fieldbus protocols, along with the increasingly growing number of SCADA/cloud protocols makes most deployments unique. As industrial IoT moves forward, standardization of these protocols will continue to make the deployments more repeatable and simpler to maintain.

EECatalog: How do the technical requirements and design challenges differ between the "industrial" Internet of Things (what we might think of as more traditional embedded applications) and the consumer side of the phenomenon?

Kitagawa, Imagination Technologies: Usually in the industrial IoT, especially on the factory floor, there is a need for deterministic real-time behavior. These devices must be highly reliable with dependable quality of service (QoS).

These same requirements are seen in the automotive market. On the consumer side, these requirements and certifications aren't as stringent.

On the consumer side, devices usually leverage connectivity such as Bluetooth LE, Wi-Fi, Zigbee and cellular technologies. On the industrial side, there are different connectivity standards to ensure deterministic behavior. Often instead of connecting directly to the Internet or cloud, industrial devices connect to a private Internet which Cisco calls the "Fog."

Across the spectrum from industrial to consumer, connecting to the cloud or the fog, all IoT devices have IP addresses. Another important commonality across all of these areas, from industrial to automotive to consumer, is the need for device security. Ensuring device security is a clear mandate for all designers of IoT devices.

Fortin, Wind River: The industrial IoT lives in a world where safety goes hand-in-hand with security. Industrial IoT devices will be connected or a part of systems that affect society. Concerns over the social values of health and privacy led to government oversight of these systems in the form of regulations, and the technical requirements for the industrial IoT must account for these regulations. It is also important to remember that these regulations are non-uniform across the globe, and many IoT systems are expected to be deployed globally, leading to architectural challenges of how to adapt the system to conform to the local regulatory requirements. Before IoT, industrial systems had the befit of isolating themselves from the Internet. But now, in order to receive the benefits of IoT (cost reduction, new revenue streams, faster innovation), these system need to be connected to either the public Internet or at least to other industrial systems. These new interfaces must be designed to maintain the integrity of the original system to meet the social obligations of health, safety and privacy inherent in industrial applications.

Many IoT systems are expected to be deployed globally, leading to architectural challenges of how to adapt the system to conform to the local regulatory requirements.

Burns, Intel: Industrial IoT has a wide variety of challenges that are not present in the consumer phenomenon. Whether it is operating a sensor or gateway in a dusty field on a tractor, next to an engine that reaches industrial temperatures, on a remote windmill without basic connectivity or in a factory that requires precise measurement and uptime, the complexity of the deployments is almost always greater. Unique communication, management, security and hardware requirements are all part of making Industrial IoT a reality.

EECatalog: We haven't come close to solving all the security issues around computing in human-to-machine applications. What's different in machine-to-machine applications, and where are we in solving security challenges there?

Kitagawa, Imagination Technologies: In M2M, issues that must be addressed include ensuring that devices are tamper-resistant, making sure that collected data is stored securely on the device and transmitted securely to the cloud or another device. In addition, only authenticated devices should be able to communicate with each other. These requirements are generally understood. Security is something Imagination is extremely focused on, ensuring that our products are designed with technologies for secure execution, secure boot and secure communications.

Fortin, Wind River: Security is a primary consideration and concern in this connected world and a security plan must be defined for any IoT system. In many ways machine-to-machine systems are no different than human-to-machine applications from a security perspective. In both systems, guards or policies must be put in place to protect against security threats, whether those threats are intentionally malicious or simply the result of faulty execution. One aspect that is unique to machines is the sheer speed at which machines can operate, which means that new security threats can be generated much faster than the policies can be created to guard against them. This leads system developers to establish positive security policies allowing systems to accept actions they normally would reject. An example is signing a potentially dangerous system command message with a security certificate from a trusted source, allowing the local system to take the positive action to accept the command based on the security credentials provided. Positive security measures can go a long way in addressing the security risks in a machine-to-machine IoT environment.

Burns, Intel: Security is one of the most critical vectors of the industrial IoT. One of the unique aspects of industrial IoT use cases is that the sensors and gateways are often focused on a specific task. This promotes the ability for tamper-resistant boot/runtime hardware and software to be able to detect variations in a use case. For example, whitelisting is an effective way to protect gateways from running unwanted software. Additionally, secure-boot technologies can help to measure the platform image to ensure that it is in a known good state. The ability to securely manage and update these policies is equally important in the lifecycle of IoT computing.

EECatalog: What's the next big IoT technical breakthrough you're anticipating and what will the impact be?

Kitagawa, Imagination Technologies: One of the next big technical breakthroughs will be in standardization. With standard APIs and protocols, all devices will be able to communicate with each other, and this will cause an explosion in consumer and industry adoption.

> ***The next breakthrough will not come from technology, but will come from understanding the business models of how to harness this technology.***

Extreme/ultra-low power devices that go well beyond what we can deliver today are also on the horizon. Such devices will ultimately remove our reliance on batteries. This is crucial since with IoT, devices must be in place for years, not just days or months. It will be critical to enable devices to be powered through techniques such as energy harvesting through motion or sunlight.

Fortin, Wind River: All of the technical elements to accelerate the IoT are already in place, such as low-cost computing power, low-cost access to wide-area connectivity and the creation of powerful analytic algorithms. I'm going to turn the question around, though, and say that the next breakthrough will not come from technology, but will come from understanding the business models of how to harness this technology. IoT will revolutionize the way the world does business, moving us from selling machines to selling the capacity to perform a service. The breakthrough will occur when companies and individuals learn how to exploit this technology to improve the welfare of society. IoT offers us the possibility to use the limited resources of the planet in a more efficient way, improving our daily lives in ways that we cannot even imagine today. Efficient use of energy in buildings, smart city initiatives and intelligent predictive maintenance are some of the ways we are looking to use IoT now, but there will be many more as the pace of innovation increases with the blossoming of this new paradigm.

Burns, Intel: Intel anticipates that with the lower cost of computing, purpose-built IoT devices may start to be replaced with more flexible general-purpose gateways. This will provide customers with a more flexible approach to implement their unique business logic on top of existing validated building blocks. A good example of this is being able to run custom analytics closer to the edge in order to allow for a more scalable solution. Another example might be to simply store the data locally on a gateway and upload it when connectivity is present or costs less in off hours.

Cheryl Berglund Coupé is a contributing editor for EECatalog.com. Her articles have appeared in EE Times, Electronic Business, Microsoft Embedded Review and Windows Developer's Journal and she has developed presentations for the Embedded Systems Conference and ICSPAT. She has held a variety of production, technical marketing and writing positions within technology companies and agencies in the Northwest.

Advanced Image Stabilization Techniques for Tablet Camera Performance

Tablet and two-in-one device designers can meet consumer expectations for higher performance image and video-capture capabilities with the latest advances in optical image stabilization technology.

By Mark Aaldering, ROHM Semiconductor

Intel® processors play a leading role in the tablet and two-in-one device market, especially for those higher-performance devices targeted at business environments and high-end consumer applications. One of the more popular applications for these devices is still photography and video capture. Market research indicates that business users and consumers prefer to use their tablets to share high-quality photos or videos on Facebook, Instagram, Snapchat or other popular, visually oriented social media sites. In fact for many users, their tablet serves as a replacement for a digital still camera or inexpensive video camera.

Not surprisingly, Intel processors help make that possible. The latest generation of the Intel® Atom™ processor, for example, not only improves overall performance and extends battery life, it also supports excellent graphics and video with integrated image signal processing for both still and video image capture. By coupling high-resolution screens with high pixel density, together with the graphics-processing capabilities embedded in Intel processors, many of today's tablets and two-in-one devices deliver extremely high-quality graphics and video.

Whether users are capturing still images or recording video, image stabilization plays a key role in producing a high-quality result by eliminating image distortion through pixel blurring and the creation of unwanted artifacts. Typically standalone cameras and mobile devices offering a photo or video function also add some form of image-stabilization capability to compensate for unintentional movements by the user. Intel-based tablets are no exception. The latest Intel Atom processor adds multi-axis document image solution (DIS) and image alignment to help remove blur from moving objects.

However, as tablet and other mobile device developers move to ever-higher levels of resolution, demand is accelerating for more advanced image stabilization techniques. Two of the more common implementations—electronic image stabilization (EIS) and optical image stabilization (OIS)— are taking video and still image photography to a new level of performance.

Basic Principles

Image stabilization techniques are designed to reduce blurring associated with relatively minor shaking of the camera within a few optical degrees while the image sensor is exposed to the capturing environment. These functions are not designed to prevent motion blur caused by movement of the target subject or extreme movements of the camera itself. This minor movement of the camera by the user is characterized by its pan and tilt components where the angular movements are known as yaw and pitch, respectively. Typically, these image stabilization functions cannot compensate for camera roll because rolling the lens doesn't actually change or compensate for the roll motion, and therefore does not have any effect on the image itself relative to the image sensor.

EIS is a digital image compensation technique which uses complex algorithms to compare frame contrast and pixel location for each changing frame. Pixels on the image border provide the buffer needed for motion compensation. An EIS algorithm calculates the subtle differences between each frame and the camera uses this information to interpolate new frames to reduce the sense of motion.

EIS offers distinct advantages and disadvantages. As an image-stabilization scheme, it offers developers a relatively compact and lower-cost option. However, image quality is limited due to image scaling and image signal post-processing artifacts and any incremental improvement in image quality requires additional power to capture additional images and perform image processing. In addition, EIS solutions do not perform well at full electronic zoom (long field-of-view) and under low-light conditions.

In comparison, OIS is a mechanical technique used in imaging devices to stabilize the recording image by controlling the optical path to the image sensor. Two primary methods are used to implement OIS. One, called lens shift, involves moving the parts of the lens. The second, termed module tilt, moves the module itself (see Figure 1).

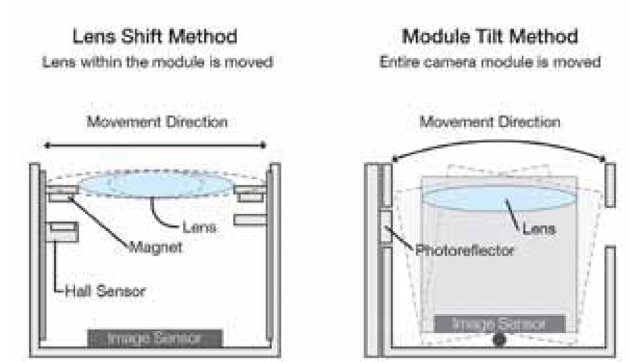


Figure 1: There are two primary methods of implementing optical image stabilization.

Camera movements by the user can cause misalignment of the optical path between the focusing lens and the center of the image sensor. In the OIS lens-shift method, only the lens within the camera module is controlled and used to realign the optical path to the center of the image sensor. The module tilt method, on the other hand, controls the movement of the entire module including the fixed lens and the image sensor. The module-tilt approach allows for greater range of movement compensation by the OIS system and achieves minimal image distortion because of the fixed focal length between the lens and the image sensor.

Compared to EIS solutions, OIS systems reduce blurring without significantly sacrificing image quality especially in low-light and long-range image capture. But unlike EIS, which needs no additional hardware, OIS solutions require actuators and power driving sources that tend to require a larger footprint and higher cost.

Module Components

An OIS system relies on a complete module of sensing, compensation and control components to accurately correct for unwanted camera movement. This movement or vibration is characterized in the X/Y-plane, with yaw/pan and pitch/tilt movements detected by different types of isolated sensors. The lens shift method uses Hall sensors for lens movement detection while the module tilt method uses photodetectors to detect human movement. OIS controllers can use gyroscope data within a lens target-positioning circuit to predict where the lens needs to return in order to compensate for the user's natural movement. With lens shift, Hall sensors are used to detect real-time X/Y locations of the lens after taking into consideration actuator mechanical variances and the influence of gravity. The controller uses a separate internal servo system that combines the lens positioning data of the Hall sensors with the target lens position calculation from the gyroscope to calculate the exact driving power needed for the actuator to reposition the lens. The process is similar with module tilt but the module's location is measured and repositioned instead of just the lens. With both methods, the new lens position realigns the optical path to the center of the image sensor.

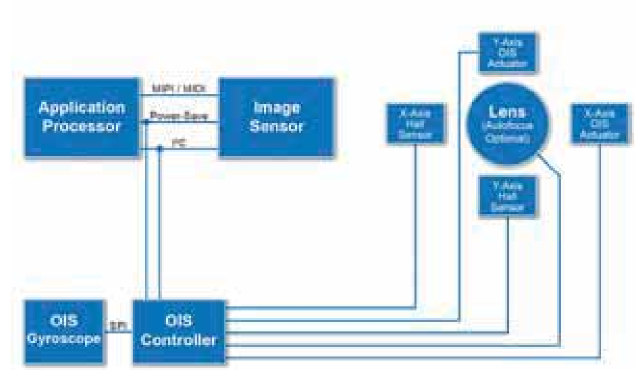


Figure 2. ROHM's OIS system uses a complete module of sensing, compensation and control components to accurately correct for unwanted camera movement.

OIS control is designed to be very simple from the customer's standpoint, consisting simply of ON/OFF and enable/power-save modes. The only other commands are optional manual control of the lens in the X/Y plane or altering OIS performance based on ambient conditions such as day, night, sports, picture, video or viewfinder. This minimizes I2C traffic from the host processor to the OIS controller and simplifies software driver development for the end customer. All of the actual OIS control algorithms are performed autonomously on the controller itself, using the internal processor and RAM.

OIS Controller Considerations

Controller architectures for OIS applications vary significantly. Some combine a programmable core with custom programmable digital signal processing for gyroscope signal processing and servo control. Others integrate programmable gyroscope signal processing and servo control into the core itself. Typically all OIS memory and control calculations are performed on the OIS controller and do not require an external host processor's computational resources or external memory.

Developers looking for a controller for OIS applications should consider a number of issues. Does the controller offer full control of the X- and Y-axis voice coil motor (VCM) drivers, Hall amplifier and current drivers and photo-reflector drivers? Does it feature the wide variety of interfaces and peripherals needed for the application including I2C, ADCs, PLL oscillators, SPI master for digital gyroscopes and support for analog gyroscopes? Does the MCU support integrated drivers for autofocus, neutral density filters or shutter functions? Be aware that some controllers offer digital filter designs in their servo control and gyroscope signal processing circuits that can improve performance by dynamically compensating for gyroscope and actuator temperature drift while not removing intentional pan and tilt movement by the camera user. Others add custom control software for automatic lens control, automatic pan-tilt detection and access to different programmable capturing modes and calibration settings.

Measuring Image Stabilization

Image stabilization is measured by suppression ratio (SR) and is utilized to gauge OIS performance. SR is calculated using a spatial test chart with a target pattern. Images of the target pattern are captured with OIS ON/OFF and with/without vibration. The images with and without OIS are then compared to compute a ratio of the amount of blur in each image. This test is typically used to provide a final guarantee that all of the components in the OIS system are functioning properly.

Figure 3 depicts examples of motion blur in the target pattern. The DSTATIC image represents an ideal result with no vibration or motion in the image. Ideally an OIS system attempts to match the quality of a still image with no motion blur and the DSTATIC image serves as a benchmark for calculating SR performance of the OIS system. In this example the DSTATIC image exhibits the shortest zoomed white area distance due to the absence of movement or blurring in the captured image. The DOISoff image represents the appearance of an image when it is vibrating or moving without using image stabilization. As a result, the DOISoff image exhibits much more blurring compared to the other images.

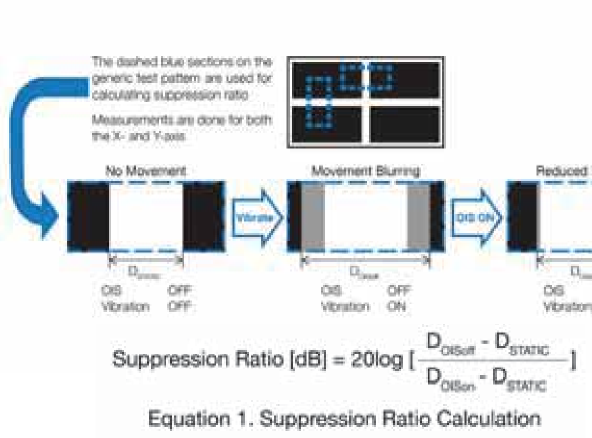


Figure 3. The DOISoff image exhibits much more blurring compared to the other images in generic test pattern.

The observed amount of blur represents what needs to be corrected or suppressed to match the DOISoff image with the DSTATIC image. Therefore, the DOISon image represents the actual benefit of the OIS system. In this example, the DOISon image depicts an image that is vibrating or moving while image stabilization is enabled. The stabilization system suppresses blurring of the image and the distance of the zoomed white area is less than when compared to the DOISoff image. Once all three images have been captured, the blurring effect of each image is measured as a function of pixel count by calculating the number of pixels within the width of the zoomed white area and then using equation 1 (shown below diagram in Figure 3) to calculate final SR. This process is repeated for each image shaking frequency performance target and for each axis.

System Testing

Proper OIS operation requires simulating the entire system to ensure that all components interact correctly together. While most OIS controller suppliers can simulate the ideal performance of golden OIS components such as the actuator, ROHM has developed highly specialized simulation tools that allow not only for simulation of OIS components, but also provide real-world OIS component simulations as well. These real-world results help accelerate the development of custom firmware for customers integrating OIS into their design (see Figure 4).

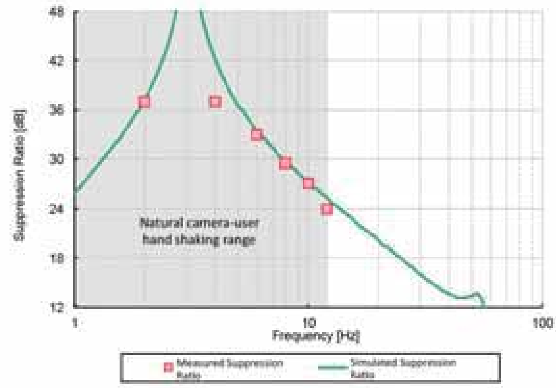


Figure 4. Graph compares real-world OIS performance vs. ROHM's simulated OIS performance.

OIS systems also require careful calibration to ensure proper operation. All of the components within the OIS system possess individual manufacturing variances and assembly misalignment variances. A properly functioning system, the OIS controller must know the subtle sensitivity variances introduced by the manufacturing and assembly processes. Once the calibration process is complete, the OIS controller can use the collected data to modify control of the system and its components.

Summary

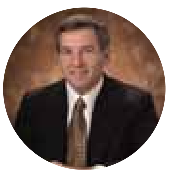
As next-generation tablets and two-in-one devices migrate up the performance curve, users will increasingly demand higher performance image and video capture capabilities. High on users' list will be crisp, clear and blur-free images. By leveraging the latest advances in optical image stabilization, tablet and two-in-one device designers can meet those expectations.

Mark Aaldering is the senior director of technical product marketing at ROHM Semiconductor, where his dedicated team drives new products into development and adoption in the computing, consumer, automotive and industrial markets.

Mobile and IoT Drive Embedded Small Form Factor Evolution

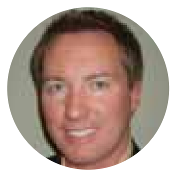
Industry experts weigh in on the implications of new SoCs from Intel and ARM, high-speed interconnects, and the Internet of Things—all in the context of small form factor embedded boards.

By Cheryl Coupé, Contributing Editor



Bob Burckle, WinSystems

Sandy Chen, Advantech



Dan Demers, congatec

In some ways, not much changes in the world of small form factor boards. There's still a remarkably wide range of form factors and standards to choose from, all of them designed to be rugged and long-lived as well as customizable and application-ready. But as always, the devil's in the details. Our panel of experts talks through what's new with respect to processors, interconnects and applications—and lots more. Our thanks to Robert A. (Bob) Burckle, vice president of WinSystems; Sandy Chen, product manager at Advantech Co., Ltd.; Dan Demers, director of marketing – Americas for congatec, Inc.; and Dirk Finstel, executive vice president of ADLINK's Global Module Computer Product Segment for their insights.

EECatalog: The embedded market is abuzz with Intel's latest processors and ARM's latest SoCs. How do these new devices impact the roadmaps of small form factor boards?

Bob Burckle, WinSystems: Both these architectures now offer great performance plus low power, which is critical for many embedded environments. Small form factor board manufacturers are moving from an "either/or" to a "both" roadmap with regards to x86 versus ARM processors. This allows them to get the benefits from each respective silicon solution as they tailor their product offerings to customer-driven requirements. These benefits vary depending upon size, cost, performance, operating systems, development tools, compatible I/O devices, drivers, long-term availability of silicon, time-to-market, etc. We have seen that industry hardware and software standards in mobile and consumer markets have migrated into the industrial sector, which makes both Intel and ARM-based processors and SOCs viable for SFF boards.

Also, interchangeable processor modules in popular open standard form factors like COM Express and Qseven ease the incorporation of new x86 and ARM SoCs into embedded systems. Following suit, SBCs offer these SoCs with bus expansion connectors that are more relevant than before. These trends are driving the usage of small form factors

Sandy Chen, Advantech: Most of current our solutions are still based on x86 architecture, but we can see that the customer needs lower power consumption or performance, lower pricing, smaller dimension, more unique I/O design to meet each different vertical solution demand.

> ***Intel® Quark™ SoCswill define a new subset of SFFs in our industry to support its features.***

In the past, Intel was not easy to approach in the very low end but super big volume market (compared with ARM) because [they had] no suitable platform to fit it. However, I suppose Intel heard not only us, but also a lot of customers' requests, so that's why their current and future solutions consider some factors I mentioned before.

As for our impact, we need to make the overall design be simplified and accurate to meet the clear vertical solution demand (because it's small, not easy to make a standard one with all functions to fit all of them), or preserve flexibility to change the I/O per various requests in an efficient way, and the overall cost and dimension should be reduced as well.

Dan Demers, congatec: First and foremost the concept of a system-on-chip (SoC) allows for small form factor board and module developers to consider future standards that further reduce overall size, which is often a desire of the system-level solution designer. The real estate savings that are found with SoCs are pretty considerable when we note that not too many years ago it took many chips to equal the benefits of these SoCs.

Another benefit to SoCs is that many also realize a power savings, which in turn helps to fuel further development on more powerful, yet less power-hungry devices. Today's SoCs are also getting a lot of accolades for their relative high capabilities for image processing, which is opening the door to many new applications. When you step back and look at what the latest Intel and AMD SoCs offer it is quite amazing. We are realizing silicon platforms that are both today- and tomorrow-focused. They contain relative high computational capability and a lot of flexibility for the board/module designer and of course the overall system design engineer. As SoCs continue to develop and evolve, small form factor board and modules designers will look to new ways to utilize the real estate gains on current form factors, as well as create new standards that continue to shrink in size in unison with SoCs.

Dirk Finstel, ADLINK: Intel´s latest SoC releases, Intel® Atom™ and Intel® Quark™ SoCs, will be adopted by most embedded vendors on all common form factors, and we will see support of newly introduced features like camera inputs and smaller displays. Intel Quark SoCs will define a new subset of SFFs in our industry to support its features.

As silicon providers like Intel and AMD continue to drive down the size, power and cost of their SoCs, there will likely be more proliferation of their platforms into the more outer layers of IoT.

EECatalog: With the evolution to 1000G Ethernet, PCIe Gen 3, M-PHY, USB 3.0, SA-SCSI, etc., signal integrity is becoming a huge factor in embedded designs. What's the impact of these faster, multi-gigahertz signals on small form factor standards? Where do you expect to see growth?

Burckle, WinSystems: These high-speed serial busses actually make designs easier. They take wide parallel busses and multiplex the data onto a serial channel. Even though there is a challenge to make sure that the signals are routed correctly on the boards using HDI rules, you only need to worry about placement and electrical issues on one or two pairs rather than a wide bus structure. Also new, low-cost interface connectors deliver excellent signal integrity in a small space. This will allow an engineer to design smaller boards as the market continues to grow for bandwidth-intensive applications such as video, storage and cloud-based networks.

Chen, Advantech: Frankly speaking, not many embedded customers do need this kind of high speed I/O. If they need it, they may consider higher-end performance platforms, and it is also related with which vertical markets they are in; if it's network communication, medical or some military applications, that may concern them more. Most of the time, the customer needs high reliability, and these high or new technologies are not so mature or might even consume higher power, or design cost will be higher compared with the legacy I/O or lower speed I/O they're using now.

Demers, congatec: A trend that has been growing and evolving for years is that of outsourcing the design of the core embedded computer for OEM products. Many companies continue to focus more and more on their core competencies and leave the computer portion to companies in the embedded computer space. In essence it has developed into a practice of leaving those aspects to the experts. Companies that design ultrasound medical devices, for example, understand the computer specifications they need for their systems, but are not always interested in reinventing the wheel, especially when they can buy something that has been vetted by years of users and is supported by a large mature industry. This trend will only continue as it gets harder to design these small form factor boards and modules. It is important to mention here that size continues to be a driving factor in embedded computer design. Sure, there are still a lot of applications that utilize larger mother boards and SBCs, but as we can see through the acceptance of tablet PCs and other handheld devices, smaller is more desirable. We are obviously not yet to nano-technology levels of design, but just think about how much smaller a Qseven module is than an ATX standard mother board. There is not a lot of space to work with, yet you are still working with the same buses and signals that require the same levels of integrity. It is certainly not a trivial scenario, and those that master the layout and placement for small form factor boards and modules will likely have even more influence on their shapes and sizes (specifications) in the future.

Finstel, ADLINK: As SI compliance always has been a mandatory requirement in our industry, times are over to play around with any kind of connector pin-outs to differentiate by form factor. We will see a consolidation of existing SFFs and slow innovation of new standards, as SI compliance doesn't provide much room for variation anymore. COMs and full custom designs are taking over the innovation in our industry. We still see some growth in PCIe-based PC/104 form factors and pico-ITX.

EECatalog: What are the top three really cool and desirable technologies being deployed in the embedded market that are most relevant to small form factor boards and systems?

Burckle, WinSystems: First is the availability of using the ARM SoC. This technology is used extensively in personal and mobile computer applications yet now it is available for use in applications with lower volumes. This is due to the wider availability of software development tools, multiple standard I/O structures for a variety of sensors and peripherals and good support from the semiconductor vendors.

Second is the multiple ways of connecting systems together either through wired or wireless links. Even though stand-alone systems can function autonomously, it is important to be able to support open standards without being tied to a single company.

Third is power. Every system must have a power source. New technology allows the electrical power requirements to be significantly reduced. IoT devices can be powered by non-fixed power sources like vehicle batteries, solar cells and wind energy as well as from Power Over Ethernet, or smaller more efficient power supplies using the grid. The net effect is more computing power with less electricity. And less energy means less heat that needs to be removed from an enclosure.

Finstel, ADLINK: Integration of LTE/3G and WLAN, security middleware and connectivity stacks—as in ADLINK's own SEMA Cloud—to enable IoT.

Chen, Advantech: 1. Intel® Active Management Technology (although it is a pity it's only supported on high end Intel® Core™i7/i5/i3 processors). 2. Quad Core platform with only 10 watts power consumption. 3. Independent display (for now may only support some limited display types still, it will be good if there is more flexibility to support multiple necessary display types in the future).

Demers, congatec: SoCs are addressing quite a number of desirable technologies that embedded system designers have been seeking out for years. First and foremost, SoCs enable small form factors to become even smaller. This is leading to system-level solutions that were not possible in the recent past. In addition, mobile applications are seeing gains due to the reduced amount of power needed to power SoCs. Finally, there have been significant advances in multicore technology in SoCs and this is driving some really interesting applications. It would also be a mistake to not mention again the importance of improved graphics and what they do for applications. When you wrap up all of these desires into a specification for the OEM product, SoCs are certainly minimizing the gap like never before.

EECatalog: Where do small form factor boards fit in the overall movement known as the Internet of Things?

Burckle, WinSystems: According to Gartner there will be nearly 26 billion devices on the Internet of Things by 2020. This means that an enormous number of physical objects need to be integrated into the information network. Small form factor boards fit well since they can be embedded in the harsh and remote areas as well as more benign environments. Small size, software compatibility and a variety of hardware and I/O platforms make them quick and easy to design into a variety of applications that continue need to be linked together.

Chen, Advantech: Low power consumption, low maintenance request (passive cooling design), lower pricing, small and compact design so we can meet more environments.

Demers, congatec: The Internet of Things is definitely a hot topic these days. In many cases x86-based and higher end ARM-based SFFs and modules are not truly addressing the farthest edge of the IoT. For example, the consumer hand-held devices like smartphones, etc. However, as connectivity becomes ever more important, SFFs and modules are substantial players in the next inner layers of the IoT. One example that comes to mind is today's industrial automation systems. These used to consist of many more "dumb" terminals and nodes throughout the system. However, now it is a reality that these devices are more connected than ever and can be utilized in much more efficient manners to truly get the most out of them for the application. As silicon providers like Intel and AMD continue to drive down the size, power and cost of their SoCs, there will likely be more proliferation of their platforms into the more outer layers of IoT. That is where the significant growth is happening and it is quite a race we are witnessing.

Finstel, ADLINK: SFF boards fit best in industrial automation, medical and transportation verticals, as high pressure for increased productivity is driving investments in IoT.

Cheryl Berglund Coupé is a contributing editor for EECatalog.com. Her articles have appeared in EE Times, Electronic Business, Microsoft Embedded Review and Windows Developer's Journal and she has developed presentations for the Embedded Systems Conference and ICSPAT. She has held a variety of production, technical marketing and writing positions within technology companies and agencies in the Northwest.

LPDDR4: Meeting the Power Neutrality Challenge in Mobile Handsets

JEDEC has defined the fourth generation of low-power DDR (LPDDR) that can help developers achieve power neutrality in handset applications, as well as improving performance and cost.

By Daniel Skinner, Micron Technology, Inc.

As new capabilities and functionality are added to mobile handsets, they become more compute-intensive. For example, in higher-resolution cameras and screens, CPUs must perform more work and memory devices must move more data, faster. Consider ultra-high-definition (UHD) video capture, which is currently a differentiating feature in high-end handsets. To support UHD video, a 64-bit system requires 25.2 GB/s of peak bandwidth.

On the surface, UHD may seem to be of limited value—after all, handsets don't have 4K displays and, as yet, few users take advantage of features like streaming UHD video to a living room TV.

UHD becomes more compelling when users want to capture moments in real time, where the most immediately available camera is often on a handset. These moments are then shared across the Internet, sometimes viewed on devices like tablets, laptops and desktops that have UHD resolution-capable screens. No one wants their priceless moments to be low-quality or pixelated. Thus, even though a handset does not directly display UHD, many users consider it important that their devices are capable of capturing, and therefore processing, that number of pixels.

The Power Neutrality Challenge

Next-generation handsets must perform more work than earlier-generation devices without decreasing battery life. Users have come to expect extended battery life and demand that the next-generation handsets maintain the same battery life (at a minimum) as their predecessors—even when they have more/improved functionality.

This concept, called "power neutrality," is a major design consideration for mobile devices. For a next-generation device to perform more work using the same amount of power, the energy required per bit processed must be cut in half across the entire system. This can be extremely difficult given that handsets depend on multiple technologies that are not advancing quickly enough to keep pace with power neutrality.

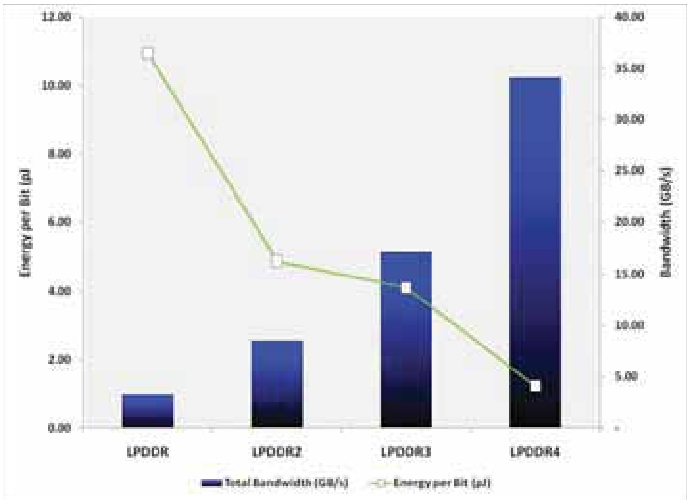


Figure 1: Mobile DRAM power requirements include active and stand-by power.

Specifically, the voltage rail has not dropped significantly—nor is battery capacity growing fast enough. The form factor for handsets is also fairly stable (with some exceptions), limiting overall battery size. Furthermore, the thermal design point (TDP) or envelope—which is the maximum amount of heat these systems can safely dissipate—is limited to 5 watts. Because the user is the final heat sink in many cases, these systems simply cannot take on more heat. Because there is nothing on the horizon to suggest that these technologies are changing any time soon, even greater efficiency is required from the other parts of the system.

LPDDR4: A More Power-Efficient Memory Solution

In today's handsets, memory devices consume up to 30% of system power in standby modes. Thus, efficiencies in memory management play a substantial role in enabling manufacturers to achieve power neutrality.

To help developers improve a system's energy consumption per bit processed (see Figure 1), JEDEC has defined the fourth generation of low-power DDR (LPDDR). LPDDR4 provides more than just a speed upgrade from LPDDR3; it's an evolutionary step up thanks to enhanced functionality that can help developers achieve power neutrality in handset applications. LPDDR4 also doubles bandwidth performance, provides a low pin-count package, is backward compatible with previous generations of LPDDR and enables competitive pricing.

The LPDDR4 standard introduces several major architectural changes that are specifically designed to reduce the energy required per bit (see Figure 2):

- 2-Channel x 8-Bank Architecture: The internal LPDDR4 architecture contains two 16-bit channels (instead of one 32-bit channel), which reduces the effects of parasitic capacitance and results in lower active currents for READ and WRITE operations.

- 2K Page Size: The reduced DRAM page size (from 4K to 2K) decreases the amount of current required to activate a page when opened.

- 1.1V Supply Voltage: The reduced supply voltage (from 1.2V to 1.1V) provides a 20% decrease in switching power and approximately 10% savings in static power.

- Advanced LVSTL Interface: The low-voltage swing (VOH) of LPDDR4's low-voltage swing-terminated logic (LVSTL) interface saves more than 50% power when switching I/O compared to LPDDR3.

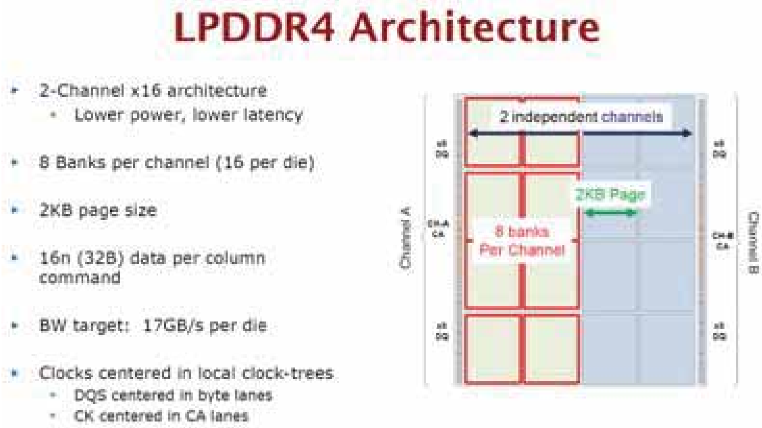


Figure 2: LPDDR4 is architected to meet the power, bandwidth, packaging, cost and compatibility requirements of the world's most advanced mobile systems.

The LVSTL Advantage

Low-voltage swing-terminated logic (LVSTL) is a significant enhancement to mobile memory technology. The LPDDR4 interface supports a programmable voltage level that divides the power supply rail for I/O by either 3.0 or 2.5. The 3.0 mode is intended for systems with better channel design and/or less loading. For more heavily loaded systems, or those with more channel losses, the 2.5 mode can be used to adjust power efficiency to increase signal integrity. This enables developers to balance cost, signal integrity and power. For example, a developer could select the 2.5 mode and use a lower-quality PCB material to reduce system cost.

LVSTL also provides a variety of termination settings, ranging from 40 ohm to 240 ohm. In general, the stronger the termination (40 ohm), the better the signal eye across the channel. However, stronger termination also consumes more power. By adjusting termination settings, developers can tune systems for a variety of configurations, such as stronger termination for a lower-end handset. This flexibility also simplifies design because developers can initially set systems to the lowest power setting (240 ohm) and increase the termination level if greater signal integrity is required.

Simplified Design Process

It is important to note that LPDDR4 is not a drop-in replacement for LPDDR3. Systems need to leverage LPDDR4's power-saving features to fully optimize power efficiency. To simplify design for developers, memory suppliers like Micron have partnered with industry-leading controller manufacturers to provide optimized LPDDR4 memory, which enables developers to focus engineering resources on their own value-added innovations. As one of the creators of the LPDDR4 standard, Micron has the experience to help developers become familiar with the new memory technology as well as design custom solutions using it.

Memory Is No Longer a Bottleneck

Because LPDDR4 provides 2X the bandwidth (up to 34 GB/s) of LPDDR3 while using less energy per bit, memory is no longer a bottleneck for UHD and other compute-intensive applications in mobile devices. LPDDR4's power efficiency enables it to be an effective enabler of UHD technology, and thanks to its flexible implementation, LPDDR4 also gives developers more options for balancing signal integrity and power efficiency and, consequently, more control over cost versus power efficiency.

LPDDR4 provides more than just stellar bandwidth, improved power efficiency and power neutrality; developers can rely on packaging with lower pin counts for greater board density, low costs and backwards compatibility to previous generations of LPDDR—all without compromising performance.

The open design of today's mobile handsets mean they should be able to do everything we want them to. With LPDDR4, they can.

Dan Skinner joined Micron in 1989 as a product engineer in the Memory Application Group, and has since worked with DRAM, SRAM, flash memory and TCAM products. Throughout his career with Micron, Skinner has held management positions in engineering and marketing, most recently managing the CellularRAM™, Mobile SDRAM and RLDRAM™ product lines. He was appointed to his current position in 2006. Skinner holds a bachelor of science degree in electrical engineering from the University of Colorado and MBA from the Kellogg School of Management at Northwestern University.

PC/104: What's Old Is New Again

Despite all the breathless excitement of the "new" Internet of Things, the PC/104 Consortium has spent its 22 years of existence helping to get the industry to this point: bringing the computer off the desktop and into the field where data is gathered and real-time decisions are made.

By Cheryl Coupé, Contributing Editor

PC/104 continues to be a major player in the embedded market. We sat down with Dr. Paul Haris, president of the PC/104 Consortium, for a conversation on how PC/104 fits in with the latest industry trends. In addition to his role at the Consortium, where Paul has held positions of chairman and president for three years, as a board member for six years, and as chair of the Technical Committee for four years, he is also president and CEO of RTD Embedded Technologies, Inc. RTD has been a part of the leadership structure of the PC/104 Consortium since it help found the Consortium in the early '90s.

EECatalog: Start out by telling me what's new with the PC/104 Consortium. What's the next major challenge you'll face, and what type of specification is likely to result?

Haris: The computer market as a whole has been evolving and expanding rapidly with the advancements of technology. Since its beginning 22 years ago, the PC/104 Consortium pioneered bringing the computer to where it was needed most: out of the building and into the field where data is gathered and real-time decisions need to be made. Today's PC/104 specifications support main bus architectures and I/O capabilities. It provides expandability, upgradability and maintainability all in an inherently rugged form factor. Last year, the Consortium expanded the capabilities of the PCIe/104 and PCI/104-Express specifications to include Gen 2 and Gen 3 PCI Express speeds. The Consortium continues to closely monitor potential evolutionary paths of the embedded market and is situated to meet its challenges. As new bus architectures evolve and become industry standards, the PC/104 Consortium is ready to incorporate them in a logical and meaningful way to ensure their continued long term use and supportability.

EECatalog: The overall embedded market is abuzz with Intel's latest processors and ARM's latest SoCs. How do these trends affect the PC/104 set of specifications?

Haris: The stackable PC/104 architecture has been supporting both high-speed processors as well as small, embedded ones for the last 22 years. It has never been limited to any particular processor type since the stacking connector incorporates mainstream bus signaling. This is why you have seen them—whether x86, ARM or PowerPC—on PC/104 modules for many years. As processors become smaller and smaller, with ever-increasing computational power, efficiency and full-feature I/O sets, the PC/104 architecture shines by being able to create fully self-contained single board computers with the added benefit of stackable expandability for additional or specialized processor and I/O functionality. All this while keeping the overall system size to a minimum.

EECatalog: There's big growth occurring in the extended temp and harsh environment markets of automotive, transportation, mining, railway, power plants and more. How is the PC/104 Consortium addressing these rugged applications?

Haris: The PC/104 architecture has always been known as an inherently rugged architecture with its stackable bus. You will find systems in the harshest conditions of land, sea, air and space. The flexibility of having the stackable backplane on each module allows OEMs and end users to create standard and custom systems that address the thermal requirements for their particular applications. For over 20 years the transportation, mining, railway, military and other demanding industries have relied on PC/104 to meet their challenges.

EECatalog: The PC market is dying, according to myriad analyst forecasts and reported numbers by PC vendors. Yet many small form factors directly map to the PC market versus the mobile market, for example. What does this trend mean to PC/104?

Haris: It is important not to confuse the type of processor architecture with the form factor and bus architecture of many standards. What we are seeing is not a dying trend but a separation of trends. As the embedded marketplace explodes, there is an ever-increasing need for point location of computer capabilities and the mobility of tasks and information gathering. To meet these needs, the x86 market has traditionally taken a top-down approach. While this was happening, a bottom-up emergence was occurring. Phones were getting smarter, more powerful and more efficient. But they were also based on a specialized, non-mainstream technology. As the demand for capability increased in the mobile market, so did the need for additional features and expansion capabilities such as PCI Express. In the end, these two competing processor architectures each has its unique markets, but there is much overlap in the middle. With its stackable backplane based on mainstream bus signaling, the PC/104 architecture has the capability to serve all of these architectures and markets giving maximum flexibility to the end user.

EECatalog: What are the most recent obsolescence issues faced (or being faced) by PC/104 vendors?

Haris: The PC/104 Consortium has always looked to the trends of the embedded market and it has guided its specifications accordingly. To ensure longevity, migratory paths to advanced technologies while maintaining mechanical backward compatibility have always been a top priority. This can be seen in the evolutionary progression of its stackable buses and their placements on the Consortium's 104 form factor. Manufactures and end user are thus given a timely evolution path for their past, present and future designs. This is what has given the PC/104 architecture such a prominent place as one of the longest and versatile industrial standards in the world.

EECatalog: What "play" will small form factors like PC/104 have in the movement known as the Internet of Things?

Haris: The "Internet of Things" terminology has often been thrown around very loosely. Simply, it is the world where devices are hooked through an Internet-like structure. It can span anywhere from the very small, such as discrete sensors and appliances, to the very large, like bulldozers and factory floors. It can include information gathering as well as control. It can allow instantaneous connectivity to your infrastructure wherever you are. But it is also fraught with a myriad of security risks. The PC/104 architecture has always been a part of this movement, before it was even considered a movement. One of the main points of PC/104 is the ability to distribute information gathering and computational capabilities out of the building to where it is needed most: the device. But unless it is to operate autonomously without monitoring, connectivity has been required, often through the Internet. In addition, the versatility of the PC/104 architecture has led to the creation of infrastructure devices such as firewalls, routers and switches. So where will you find PC/104 in the Internet of Things? Everywhere.

So where will you find PC/104 in the Internet of Things? Everywhere.

Cheryl Berglund Coupé is a contributing editor for EECatalog.com. Her articles have appeared in EE Times, Electronic Business, Microsoft Embedded Review and Windows Developer's Journal and she has developed presentations for the Embedded Systems Conference and ICSPAT. She has held a variety of production, technical marketing and writing positions within technology companies and agencies in the Northwest.

ATCA-7475 40G Packet Processing Blade

The Artesyn Embedded Technologies ATCA-7475 is a 40G AdvancedTCA® (ATCA®) packet processing blade that enables the highest packet processing performance and security features in an ATCA form factor. It allows you to consolidate packet, application and control processing functions in a single blade architecture and benefit from lower development costs and the use of common tool suites. This can get you to market faster and enable you to balance workloads efficiently across the available hardware resources.

The ATCA-7475 is designed to exploit the full capabilities of the two 10-core Intel® Xeon® processors E5-2600 v2 product family and Intel® Communications Chipset 89xx Series, with an optimized balance of processing, memory, I/O, data movement and interfaces.

The fabric interface provides redundant 40G (KR4) capabilities for applications requiring the highest network throughput in the backplane, with the ability to run both fabric interfaces at full speed. The optional crypto accelerator module features two Intel® Communications Chipset 8920 devices to off-load en/decryption, compression tasks from the CPUs. Main memory configuration and mass storage options can be flexibly configured to provide a perfect fit to the needs of your application.

Multiple available rear transition modules provide a flexible combination of storage and I/O, with options for high capacity redundant storage or up to 6x10G Ethernet interfaces. This allows the ATCA-7475 to be easily integrated into different network infrastructures. The blade is optimized to work with Artesyn's range of ATCA system platforms which cover two-slot, six-slot and 14-slot variants that are designed to meet the needs of both telecom central office and network data center environments.

Key Features

- High performance Intel® architecture packet processing blade
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- Up to 128GB main memory
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ADLMES-8200 High-Ingress Protection (IP) Modular Enclosure Systems

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Potential Applications Include:

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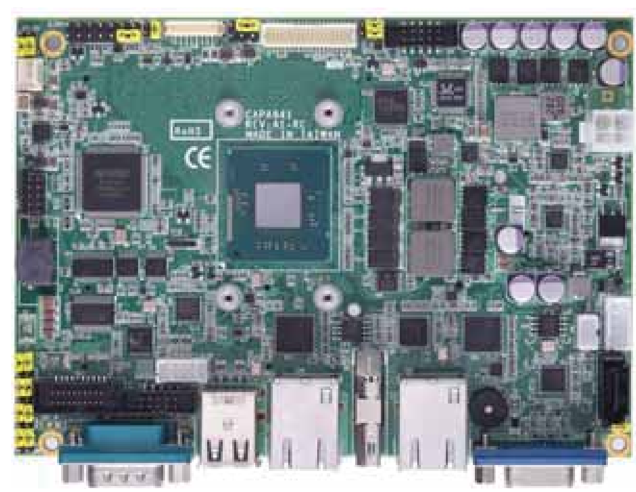
CAPA841 – 3.5" Embedded SBC with Intel® Atom™ Processor E3800 Series

Axiomtek's CAPA841 is one of the world's most advanced 3.5-inch embedded boards. Equipped with the newest 22nm process Intel® Atom™ processor E3800 series, this tiny system-on-chip (SoC) incorporates up to four cores and supports system memory DDR3L-1066/1333 SO-DIMM of up to 8 GB. The fanless CAPA841 operates under a wide range of temperatures (-40°C to +85°C) and offers great flexibility to systems integrators who design rugged systems for operations in harsh environments. This feature-rich, small form factor board comes equipped with multiple display outputs including HDMI, LVDS and VGA with dual view support. It offers integrated Gen 7 graphic engines of up to 792MHz in turbo, faster media processing, full HD over HDMI and spectacular HD playback for enhanced visual experience.

The CAPA841 works well with Windows 7 and 8 operating systems. It offers great connectivity including four serial ports, two of which can be RS-232/422/485 in BIOS selectable, and utilizes +5V/+12V power supply. It also offers four high-speed USB 2.0 ports, two Gigabit Ethernet ports with Intel® Ethernet Controller I210-IT, HD audio, SATA-300 port, CFast™ socket, digital I/O and SIM socket. This advanced SBC includes one full-size PCIe Mini Card with mSATA support and one half-size PCIe Mini Card. The WDT feature keeps the system running smoothly. The CAPA841 is a great and only logical choice for customers who need a high-performance, low-power, smart, feature-rich, 3.5-inch embedded board.



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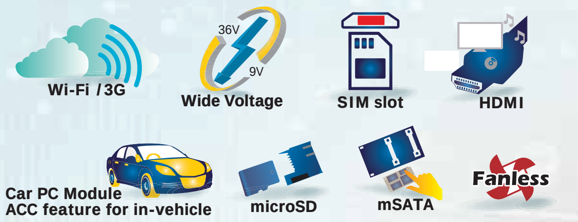
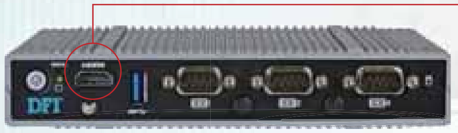
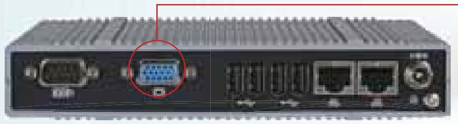




EC700-BT Front View

Dual Display


EC700-BT Rear View

EC700-BT	
Processor	Intel® Atom™ Processor E3800 Series
Memory	4GB/2GB DDR3L ECC onboard
Storage	1 2.5" SATA drive bay and 1 mSATA, eMMC onboard (optional)
Display Output	1 HDMI + 1 VGA or 1 DVI-I
Ethernet	2 Intel® Ethernet Controllers I210-AT
Expansion	3 Mini PCIe slots for Wi-Fi, 3G, GPRS or storage
USB	1 USB 3.0 (Type A), 4 USB 2.0 (Type A)
COM	4 COM: - 3 RS232/422/485 - 1 RS232/422/485 or 8-bit DIO
Power Input	Wide Voltage 9~36V DC-in
Operating Temperature	0°C-60°C (SSD/mSATA/CFast); 0°C-50°C (HDD)
Dimensions	180mm x 33mm x 121.2mm (W x H x D)
Construction	Aluminum + metal aluminum
Mounting	Wall/VESA mount
Optional Module	Battery Backup module, Car PC module

Free utility for monitoring the power status of the battery backup module

intel IoT Solutions Alliance

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A 3-Tier Approach to IoT Security

To ensure the functionality of an IoT system, software designers should consider a 3-tiered stack of controls, where the lowest level ensures the integrity of the next.

By Greg Brown, McAfee a part of Intel® Security

The Internet of Things (IoT) ecosystem offers the opportunity to interact with daily items in a whole new way. Pervasive connectivity, affordable, embeddable compute platforms and rich inter-system interaction enabled by cloud technologies allow us to access and analyze data from physical systems in new ways. This enables greater levels of controls to improve the operation of the machine, improve business efficiencies or enrich the user experience. Our challenge is to make sure that we don't allow today's cyber-security risk to put us into a repeat cycle of the Y2K rollover issues.

When an embedded system is isolated physically, the security concerns are limited to the physical access to that machine. The moment we consider enabling network or cloud connectivity we need to redraw the boundary of the machine to include any and all systems that could exchange information with our system. Note that I use the word "could" not "should." The potential for access to our machine is the hacker's point of opportunity. That opportunity can be exploited as a result of the design or as a result of the deployment of the system. For example a hacker may take advantage of a newly discovered vulnerability in broadly adopted open source software, which was the case with the recent Heartbleed vulnerability in OpenSSL.

Alternatively, the hacker may take advantage of risks created at the time of deployment. I recently heard about an HVAC system that was designed to provide control access over an IP network. The system integrator installed a DSL line that allowed them to monitor the system remotely, and effectively created a backdoor into the owner's private network.

There are three technologies that an IoT software designer should consider to ensure the functionality of an IoT system. We should think of them as being a tiered stack of controls, where the lowest level is ensuring the integrity of the next level.

1. **Secure boot controls** utilize hardware controls to ensure that the OS and bootloader haven't been tampered with at the time of system initialization. It is important to include the operating system security enforcement components in the startup evaluation. Effectively we want to compare the state of our boot environment to a well-known state.

2. **Application control** provides execution control at run time. We want to ensure that only our executable code can be loaded into the CPU stack. Even if a hacker were to find a vulnerability that enables him or her to tamper with memory, application control prevents the CPU from attempting to run any exploit code that they may have been able to load on the system.

3. **Configuration** control gives us control over user or environmental parameters that govern the behavior of our software. It is important that the configuration parameters are loaded into our system in a way that is either assured by a known input driver/application that is enforced by application control or assured by secure boot controls.

These controls represent a comprehensive way to implement positive control over the software execution environment. Conventional software quality process still needs to be applied to the system, but the unknown software risks are effectively eliminated.

Finally, any effective security control should be able to identify when unacceptable conditions arise, and we must have a way to appropriately escalate those for user awareness or intervention. In conventional IT systems that is the security management console or a security event and information management (SIEM) system. For our IoT system, we need to integrate security events into the operate console, and potentially into the overall security and compliance management system.

Greg Brown joined the McAfee network security team in 2006. Brown has 20 years of experience in the network security and telecommunications industry, working with silicon technology vendors, security software/hardware vendors and service providers. He has provided design consultant services for national IT security infrastructure programs on four continents. Brown was the principal designer for first-time national Internet infrastructure programs in more than 30 countries.

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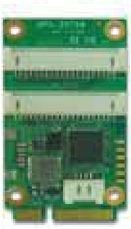

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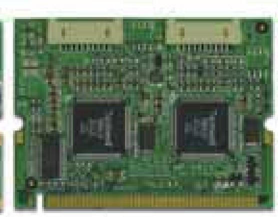

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