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Engineers' Guide to Industrial Computing

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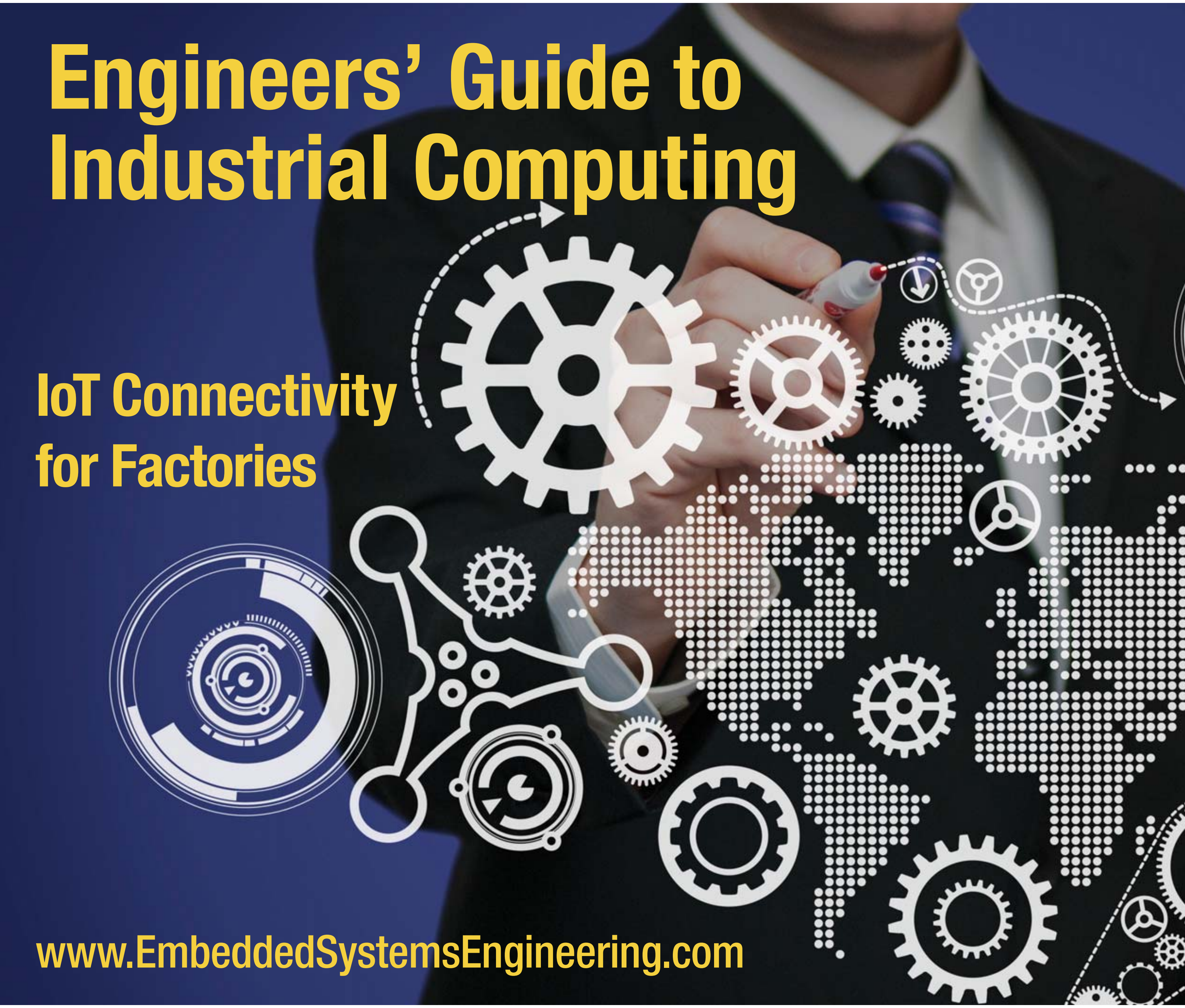

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CONTENTS

EMBEDDED SYSTEMS ENGINEERING

Features

Product Showcases

Engineers' Guide to Industrial Computing
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Four ARM-Based MCUs Add IoT Connectivity For Vehicles And Factories

By Caroline Hayes, Senior Editor

At this year's Consumer Electronics Show in Las Vegas, Nevada, Atmel unveiled the first four devices in a planned series, combining the impressive processing power of an ARM® Cortex®-M7 with a variety of connectivity peripherals to target industrial and automotive use.

The SAM V70, SAM V71, SAM E70 and SAM S70 extend the company's SMART ARM MCU family and target the industrial market (E70 and S70) and the automotive market (V70 and V71) by exploiting the processing power of the ARM Cortex-M7 and by providing a range of connectivity options (see Figure 1). The ARM Cortex-M7 includes DSP extensions in its instruction set for single cycle 16/32-bit multiply-accumulate and single cycle, dual 16-bit multiply-accumulate to accelerate many arithmetic and DSP operations.

The company identified Internet connectivity as a key factor in the design. "There are two trends," says Nicolas Schieli, MCU marketing director at Atmel,"the first is for user differentiation in the automotive market, and the other is for in-vehicle Internet connectivity for audio and video. [Atmel] intends to participate in this trend using the Cortex-M7 and peripherals."

Figure 1: The Cortex-M7 based, general-purpose SAM S70, the connectivity-focused SAM E70, and the automotive-qualified SAM V70 and SAM V71 add to the existing SAM MCU family from Atmel.

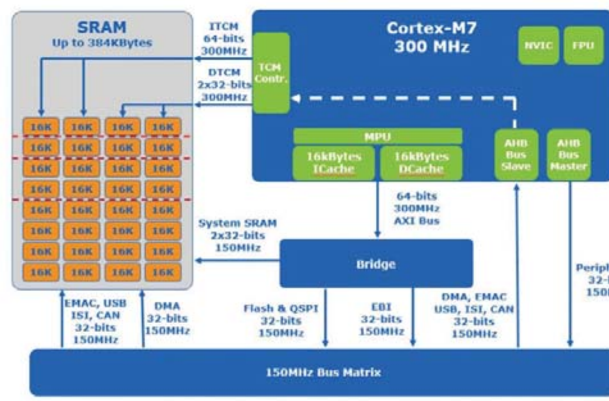

Figure 2: The internal architecture of the SAM MPUs based on the ARM Cortex-M7.

The company has developed a multi-port SRAM for these devices that can be configured to create tightly coupled interfaces or as system memory. This is a distinguishing feature of Atmel's design, points out Schieli; all other MCUs have a fixed memory assignment. With this configurable, multi-port SRAM, the designer can decide how much to dedicate to high-speed tightly coupled memory. It also allows simultaneous (superscalar) access to memory for single-cycle operation. There is no need to slow down the system to access the SRAM, says Schieli, allowing time-sensitive data to move through the network at a predictable latency.

Atmel describes the Cortex-M7-based MCUs as "a big leap." "We believe that the key value of these new devices for the customer is that they are based on the Cortex-M7 core, which offers a significant uplift in performance, is easy to program, and has the broadest ecosystem. It enables customers to use power-efficient microprocessor units (MPUs) to significantly reduce overall system cost, from both a bill of materials and a development point of view."

CONNECTIVITY FEATURES

In addition to the ARM Cortex-M7 with its integrated Floating Point Unit (FPU), the MCU includes high-speed USB-on-the-Go, on-chip, high-speed USB PHY and Flash memory densities of 512kByte, 1Mbyte and 2Mbyte. Other peripherals include interfaces for I²S and Secure Digital/

MultiMedia Card (SD/MMC), a CMOS camera interface, system control and analog interfaces as well as up to eight universal asynchronous receiver/transmitters (UARTs). An on-chip USB transceiver enables direct connection to high-speed USBs (see Figure 2).

The SAM E70 has an additional 10/100 Ethernet MAC and Dual Bosch Controlled Area Network-Flexible Data (CAN-FD)—the CAN data link protocol interface, which, together with analog interfaces common to all devices in the SAM series, are significant for industrial applications and for automotive, says Schieli.

The SAM V70 and V71 (Figure 3) are the industry's first automotive-qualified Cortex-M7 based MCUs; they have the same features as the SAM S70 plus Media Local Bus (LB) peripheral capabilities for audio connectivity within the vehicle. The SAM V71 also has Ethernet Audio/Video Bridging (AVB) support and CAN-FD support.

TARGET MARKETS—AUTOMOTIVE

The development of the multi-port SRAM is significant to meet both

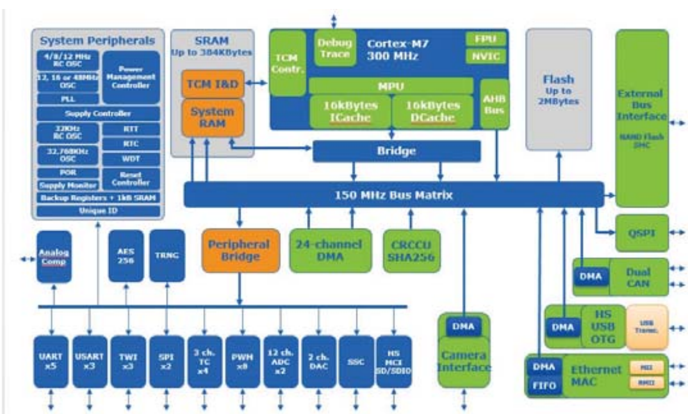

Figure 3: The SAM V70 and SAM V71 are designed to connect audio amplifiers, telematics and head unit control for in-vehicle infotainment. Its companion chip, the SAM V71 (pictured) additionally has Ethernet AVB support.

identified trends of differentiating a product in the automotive market and Internet connectivity. The SRAM allows the user to decide how and where to attach a zero wait state memory and how to dedicate a high-speed interface for a particular role.

The Cortex-M7 core supports another clear trend identified by Schieli, Ethernet AVB, which provides the path to higher-bandwidth, deterministic interfaces.

This requires a guarantee of quality of service so that there is no interruption to the audio. Rather than host this feature in software, it is hosted automatically by the Media Access Controller (MAC). "This way, the Cortex-M7 is freed to do DSP audio processing, a capability it more than excels at," explains Schieli.

ETHERNET CONNECTIVITY

The SAM V70 and V71 devices receive audio packets over Ethernet AVB and condition them for audio playback on the Cortex-M7 processor.

To differentiate products in the cost-sensitive automotive market, the MPU plays a significant role. "Customers wanted an MPU which enables the partitioning of the memory sub-system," says Schieli. "Once we had the flexibility of the system architecture of the Cortex-M7, we were able to provide the wide variety of efficient interfaces needed for different markets."

Support for Media Local Bus (LB) enables a single bus to connect multiple processors together and to connect the Media LB to Media Oriented Systems Transport (MOST) devices for connected infotainment buses within a vehicle. This is another distinguishing feature of the Media LB, notes Schieli, as it enables each module to connect over the established MOST or Ethernet AVB. Automotive designers can use these devices to migrate to the Ethernet AVB protocol and reuse them without having to undergo a redesign, he says.

TARGET MARKETS—INDUSTRIAL

The SAM E70 and SAM S70 provide connectivity in industrial applications, with analog interfaces, common to the SAM series, but which are particularly important for industry, says Schieli. The analog front end is a high specification Analog to Digital Converter (ADC) operating at 2Mbyte/s, typically used in motor control applications.

PERFORMANCE METRICS

All four devices operate at 300 MHz and achieve a CoreMark score of 1,500, more than double that which is achieved with the Cortex-M4 based SAM 4 family. The configurable SRAM is larger than earlier versions, up to 384kByte, sufficient to buffer audio without the need for external memory, and thus reduces bill of material costs, according to Schieli.

ROADMAP AND SUPPORT

The SAM E70 is the first of Atmel's Cortex-M7 MPUs to be released and is already available for general sampling. The company has also released the ATSAMV71-XULT Xplained development kit.

The established and significant ARM ecosystem will also provide support in the form of an IAR compiler for the Cortex-M7, and Atmel's Studio 7 includes compiler support for the Cortex-M7. Ethernet AVB stack is available, and an AutoSAR software offering is also in development for the SAM V70 and SAM V71.

GE Rugged: Opportunity Beyond The Battlefield

Chris A. Ciufo, Editor-in-Chief, Embedded Systems Engineering

Here's a Q&A with the man charged with beating GE's rugged high-rel swords into ploughshares targeting transportation, industrial, energy…and more mil/aero platforms.

GE—famously intending to be #1 or #2 in all target businesses—sees great synergy in applying the experience and expertise it has developed in rugged hardware, software and services—what the company calls "GE Rugged"—in the mil/aero market and applying them much more broadly, into industries and markets that need to deploy high performance computing into harsh environments in applications such as transportation, infrastructure, energy/power and industry. More importantly, GE's long-term focus on the Internet of Things (IoT)—which the company calls "The Industrial Internet"—needs the technology that's readily available off-the-shelf from the rugged embedded group.

I caught up with the man tasked with communicating this message, Rubin Dhillon. Edited excerpts follow.

Chris "C2" Ciufo: Is GE abandoning the military space?

Rubin: No, that's absolutely not the case. Today, the majority of our embedded computing business is military and our internal structure and processes are built to address the unique challenges of military programs. But why not expand this to all the other industries where GE is such a big player? The machines that form the Industrial Internet demand rugged embedded computing as well.

C2: Can you define "GE Rugged"?

Rubin: You're going to hear a lot throughout the year about "GE Rugged" and what that means for our business. When we think of rugged and we talk about GE Rugged we're not just talking about rugged boxes, or rugged boards or the traditional levels of ruggedization. That's only one piece of it. We actually see it encompassing everything—products, service, support, lifecycle management and so on. In the spaces that we serve, selling rugged embedded hardware to mission-critical applications—whether it's a military platform or a safety-critical machine on an oil rig—there are things above and beyond the piece of hardware that make it unique for that industry.

C2: Let's tackle "ruggedness" first, then.

Rubin: Sometimes I assume that everyone knows the difference between truly rugged by design and rugged as a bolt-on afterthought—and there's a surprising amount of the latter around. In the case of GE Intelligent Platforms' rugged products and systems, we start with extended temperature, shock and vibration, humidity protection, ESD, and other key environmental metrics from the very beginning. Our components, PCBs, mechanical assemblies—such as stiffener bars and heat sinks—are chosen to meet our five ruggedization levels (Figure 1).

Ruggedization Level 1 Standard (Air-cooled)	
Operating Temperature	0 to +55°C with 300 linear ft./min. airflow
Storage Temperature	-50 to +100°C
Vibration	0.002g/Hz from 10 to 2000Hz random and 2g sinusoidal from 5 to 500Hz
Shock	20g peak sawtooth, 11mS duration
Humidity	Up to 95% RH
Notes: Commercial grade, for use in benign environments and software development applications.	

Ruggedization Level 2 Extended Temperature (Air-cooled)	
Operating Temperature	-20 to +65°C with 300 linear ft./min. airflow
Storage Temperature	-50 to +100°C
Vibration	$0.002g^2/Hz$ from 10 to 2000Hz random and 2g sinusoidal from 5 to 500Hz
Shock	20g peak sawtooth, 11mS duration
Humidity	Up to 95% RH with varying temperature, 10 cycles, 240 hours
Notes: Similar to standard, conformally-coated for added protection and temperature characterized.	

Ruggedization Level 3 Rugged (Air-cooled)	
Operating Temperature	-40 to +75°C with 600 linear ft./min. airflow
Storage Temperature	-50 to +100°C
Vibration	$0.04g^2/Hz$ 20 to 2000Hz, with a flat response to 1000Hz, 6dB/octave roll-off from 1000 to 2000Hz
Shock	20g peak saw tooth, 11mS duration
Humidity	Up to 95% RH with varying temperature, 10 cycles, 240 hours
Notes: Wide temperature, conformally-coated for added protection. Optional Environment Stress Screening (ESS).	

Ruggedization Level 4 Rugged (Conduction-cooled)	
Operating Temperature	-40 to +75°C at the thermal interface
Storage Temperature	-50 to +100°C
Vibration	Random, $0.1g^2/Hz$ from 15 to 2000Hz per MIL-STD-810E Fig 514.4 - 8 for high performance aircraft. ~12g RMS
Shock	40g peak saw tooth, 11mS duration
Humidity	Up to 95% RH with varying temperature, 10 cycles, 240 hours
Notes: Designed for severe environment applications with high levels of shock and vibration, small space envelope and restricted cooling. Optional Environment Stress Screening (ESS).	

Ruggedization Level 5 Rugged (Conduction-cooled)	
Operating Temperature	-40 to +85°C at the thermal interface
Storage Temperature	-50 to +100°C
Vibration	Random, $0.1g^2/Hz$ from 15 to 2000Hz per MIL-STD-810E Fig 514.4 - 8 for high performance aircraft. ~12g RMS
Shock	40g peak saw tooth, 11mS duration
Humidity	Up to 95% RH with varying temperature, 10 cycles, 240 hours
Notes: Designed for severe environment applications with high levels of shock and vibration, small space envelope and restricted cooling. Optional Environment Stress Screening (ESS).	

Figure 1: GE Intelligent Platforms' ruggedization levels, in air- and conduction-cooled flavors.

I don't want to go into too much detail here since you can read about all this on the GE IP Embedded Systems website, but the key message is how intentional our engineers and programmers are in the design, evaluation, assembly, test and verification stages. Let me give you an example. Everyone knows NVIDIA as a world leader in graphics silicon, and most people think of NVIDIA when it comes to PC gaming technology. What you may not know is that GE utilizes that same technology to bring massive amounts of computing performance to military and industrial applications, all while consuming very little power. GE is NVIDIA's preferred provider of embedded GPU solutions to serve applications in harsh environments. Today, that means that we provide an extended temperature version of NVIDIA'S blazingly fast multicore Tegra K1 GPU—and we do it with full knowledge of the device's characteristics at temperature extremes.

Sometimes we de-rate our designs accordingly, such as for the K1 SoC, to assure high MTBF at all four corners of the device [semiconductor] shmoo plots. For the memories, we know how they perform over temperature (they're faster at lower temperatures), and build that margin into our total design. The net result—whether we're discussing the components, the board, or the whole system with software—is that it's guaranteed to operate within the specs we describe.

Now, an IEEE 1101.2 conduction-cooled and deployable VITA 46 3U VPX board is going to be overkill for the development phase of any program—whether it's an airborne avionics flight controller or a piece of down-hole oil exploration equipment—so our Level 1 air-cooled versions are designed to be 100% circuit- and software-compatible. My point: after over 250 designs, this is the intentional part of GE Rugged design.

You can read about all of this, with details for other environmentals like shock and vibe, sand and dust and moisture, EMI and even nuclear and EMP. It's all part of our design specs and factored in.

C2: I think I see. But how applicable is GE's embedded group and GE Rugged to the overall GE strategy?

Rubin: First of all, we are part of Intelligent Platforms, which is a key element within GE's initiative in the Industrial Internet (Figure 2). While others may be talking about the Internet of Things as the future of the industrial sector, Intelligent Platforms is making the Industrial Internet real today. We are delivering the hardware, software and big data analytics that bring the benefits of the Internet economy to

Figure 2: GE's Industrial Internet is the company's vision for connecting all kinds of "brilliant machines" on the IoT. Here a connected locomotive run by GE Rugged embedded electronics reports telemetry data.

industries like automotive manufacturing, avionics, food and beverage manufacturing, defense, mining, oil and gas, power and energy…even water and waste water. In order to take part in this new Industrial Internet world, where data has become the hottest commodity, the machines in these industries must get smarter. That's where our Embedded business comes in—we are embedding the intelligence into those machines.

As part of the Intelligent Platforms division, we're creating some of the "brilliant machines" that are part of the Industrial Internet. From an embedded group perspective we're embedding the intelligence, the computing, the connectivity, and the analytics to make those machines brilliant.

These machines take the forms of big gas turbines, aircraft engines, heavy industrial equipment and, yes, military platforms like vehicles. When these machines are connected and share their data, we call them brilliant machines.

C2: GE has its own version of the IoT, yet the IoT has limited traction so far in the DoD.

Rubin: I disagree with you about the DoD and the IoT. While it may be true that the military isn't talking much about the IoT or yet using this term, the "connected battlefield," "sensor fusion," and "integrated battlespace" have been U.S. DoD initiatives for several decades. Our armed forces have also been talking about network-centric warfare for some time: it's all about leveraging the power of the network and getting at the data whether it's in a factory or on the battlefield. In fact, all branches of the service have been required to "share assets and intelligence" by top-down mandate for a long time.

The military has been talking about everything on the battlefield being a sensor, every sensor being connected, all the data going up into the cloud, and all that data providing intelligence, surveillance and reconnaissance (ISR) like never before. What we're trying to do in the industrial world is exactly the same thing except all the pieces of (big) hardware look different, and they're not getting shot at.

Any notional battlefield PowerPoint slide you find for most defense programs is going to show how sea-, ground-, airborne- and space-based platforms are all interconnected and sharing data in order to achieve mission objectives. It doesn't get more connected than this. I argue that the DoD was doing the IoT well before the rest of the world.

GE calls it the "Industrial Internet" because that is how our customers know us—an industrial giant. But it's broader than what people might typically call "industrial." When I talk to people about the Internet of Things, I often joke that we at GE are enabling "the Internet of really big things."

C2: How far down the road are you in terms of your ability to bring GE Rugged to other industries and markets?

Rubin: GE Rugged is not new. We have been doing this for years—longer than most embedded companies. "GE Rugged" gives us an easy way to encapsulate all of the benefits we can bring customers who may not know us yet. As I mentioned earlier—it's more than just hardware and more than just military.

Let me give you an example. At NVIDIA's March 2015 GPU Technology Conference [GTC] we showed a compelling demonstration of how combining NVIDIA's expertise in GPU technology and GE's expertise in rugged embedded computing solutions will allow high performance computing in the most challenging, inhospitable environments: onboard a spacecraft, and on the surface of the moon.

Figure 3: The Griffin spacecraft developed by GE customer Astrobotic in partnership with Carnegie Mellon University uses GE Rugged electronics.

The Griffin landing vehicle concept by our customer Astrobotic uses GE's MAGIC1 system (Figure 3). This is a clear example of how technology that was targeted at military customers is finding its way to other industries.

C2: Let me get this straight. You're talking about changing the narrative to more than just rugged boxes and to include the GE Rugged infrastructure. Is your messaging with GE Rugged intended for non-military customers…the people and companies who wouldn't normally think of rugged, safety-critical, end of life and so on?

Rubin: Yes, absolutely. For example, we're bringing this to transportation applications today; we've done a lot of work with our colleagues at GE Rail. A GE Locomotive is one of those "really big things" that is built to be tough, and these days, smart.

Transportation is just one example of an industry looking to implement very powerful computing far out on the edge of the network—far from the air-conditioned data centers, far from benign computer rooms but right out at the edge nodes, where the rubber really hits the road—or the wheels hit the track—where, if you can deploy the processing power necessary in harsh, unforgiving environments that are strapped for power—that's when the whole IoT thing starts to come alive—when you have your brilliant machines not just in railroad signal boxes, but in the locomotives themselves.

Let's look at the hardware itself. The computers and networking gear that we install in locomotives do not look very different to the typical cold plate mil/aero vetronics boxes filled with 6U VME or VPX boards. These systems enable things such as positive train control or automatic braking in a diesel/electric locomotive, and even big data analytics as part of the Industrial Internet. The environment is literally "big iron": it's hot, it vibrates from the rails, and the environment can get very dirty from water, mud—even diesel fuel or hydraulic fluid. In short: it's not much different from an armored vehicle like the U.S. Abrams tank or the U.K.'s SCOUT (Figure 4).

Getting back to that GE Rugged message, you can see that our existing "ilities"—such as reliability, maintainability, configurability and so on—apply equally to a locomotive. For example, within our embedded group we have a documented Product Lifecycle Management [PLM] plan for long-term support. This applies to strategic and mission-critical electronics and systems that must be maintained for years to decades.

Since components can go obsolete despite our best design efforts, we maintain a quarterly health check on the industry, looking for obsolescence notices and anticipating obsolescence before it happens so we can notify our customers. When end-of-life [EOL] becomes a reality—and it does with shocking regularity in the semiconductor industry—we can inventory components and guarantee delivery of embedded electronics for as long as required. This applies equally to color-of-money budget-constrained DoD programs as well as NRC regulated power plants.

C2: So GE Rugged—the message, that is—doesn't apply to the military/aerospace companies that already know GE Intelligent Platforms?

Rubin: Actually, it does. The other piece of this is reminding military customers—the companies that support the DoD, MOD and so on—that not all COTS from all providers is the same.

A few years ago we had a large win with a customer who had been doing decent business with us year over year and they decided—there's all sorts of "COTS rugged" switches we can buy and we don't need the military-specific one you've built for us. Look at all of these guys building industrial rugged switches!

So they designed us out and went with another supplier to "save a ton of money." It was something like three or four months later the customer came back and asked to get us back into the program. We found out they had some problems, some technical issues regarding their network architecture. They had set up a conference call with their

Figure 4: GE recently announced a $100m order from General Dynamics for nearly all of the electronic computer and connectivity systems on the UK's next-generation armored vehicle, the SCOUT. (Courtesy: General Dynamics.)

supplier and halfway through the call they realized the engineers who were answering all of their questions were not in the U.S. on this ITAR program. Their supplier had no clue that this would be a problem because they don't play in this industry.

Figure 5: Rocket launch, including the GE Rugged embedded system controlling the terrain vision that will help Astrobotic and its partners get to the moon. (Courtesy: YouTube; Astrobotic.)

The customer came back, we're designed back in, and they realize what they're getting for the money they're paying. While the hardware and software is all very similar, the suppliers are not and some of our customers need to be reminded. This is an example of GE Rugged: understanding the customer's customer and having the right support infrastructure. While ITAR doesn't apply to a medical customer, FDA certification certainly does in "mission critical" medical equipment such as that found in an air ambulance. Are you seeing what I mean by GE Rugged?

C2: Can you cite an example of a non-mil rugged success story?

Rubin: I alluded to one earlier. We're working with the company Astrobotic where our rugged systems are enabling them to go to the moon. The Google Lunar X Prize has various companies competing for the goal to send a rover-like robot to the moon that will land, roam around and send real-time high-def images back to earth. Google is giving away millions and millions of dollars in an effort to give today's younger generation the same sort of experience the previous generation got when we put a man on the moon.

Astrobotic is a front-runner in this competition, and it has performed various tests where it has simulated its rover going to the moon. We have video footage from those tests.

Figure 6: Simulated "lunar" surface from the Astrobotic Andy rover. (Courtesy: YouTube; Astrobotic.)

If they're successful, GE solutions will be going to the moon with them in 2016.

The Astrobotic landing system uses a GE Intelligent Platforms MAGIC1 rugged display computer that's equipped with an NVIDIA GPU, creating an onboard HPEC system that is very sophisticated and reads data from onboard cameras, lasers, INU and more. This GE Rugged COTS system will help calculate the Griffin lander's position, provide nav feedback, and help the system land and deploy the onboard Andy rover. The rover that will launch from the landing craft features a Tegra K1 processor—delivering 326 GFLOPS of performance while consuming less than 10 watts of power—to capture, compress and transmit high-def video.

To get the competition money, Astrobotic has passed several tests/milestones, including a rocket launch using a demo test bed. The video is pretty impressive (Figure 5). In Pennsylvania there is a mine slag pit where the terrain looks like the moon with rocks and craters, and the sand is the same color (Figure 6). To simulate the rover's operation on the moon, Astrobotic took its products to the slag pit, and shot terrestrial video footage from there. This isn't a military application, but it helps show how GE Rugged is applied.

C2: You mentioned locomotives earlier. Is a fleet of diesel/electric locomotives similar to a fleet of armored vehicles?

Rubin: You can easily see how the analogy applies to a fleet of military vehicles—Abrams, MRAPs, Bradleys, SCOUTs—it's the same sort of thing. They move around, they've got maintenance, and they're interconnected. One can show the Army how the Industrial Internet benefits them. And how some of GE's built-in predictive maintenance capability found in industrial controls ought to be added to their vetronics systems.

In February we announced a huge order from General Dynamics on the UK's next-generation armored vehicle, the SCOUT program. We won nearly all of the electronic computer systems and connectivity systems on the vehicle, valued at $100M. Read up on this and you'll see it's all about the same things we've been discussing: making it a sensor, making it run more efficiently and making it more lethal. And it's the electronics that enable [the platform] to do that.

I believe there were three key reasons we won that program, besides meeting the technology criteria. The first was our packaging that optimized size, weight and power [SWAP]. You'd think there'd be lots of space in an armored vehicle, but there's not. Secondly, the British Army and GD needed that GE Rugged NVIDIA GPGPU technology we talked about. And the third reason—and this really drives home the point about Big GE "cross-pollination"—was our OpenWare switch software that's found its way in non-defense networking applications.

The GE Rugged infrastructure can apply to locomotives (Figure 7), vetronics, and all manner of embedded systems. It's the technology, the talent and who we are.

C2: A year ago I wrote about GE's Research Center and some key thermal patents and advancements. I'm assuming this fits into GE Rugged somehow?

Rubin: Yes, you guessed it. This is a great example of how GE Rugged is different from other "rugged" offerings. This is something no other company can match: the deep technology and core research available from GE, as your article "Taking the Heat" described about our GRC.

I don't want to talk too much about it here, but soon our customers will be able to take advantage of those unique thermal technologies that the GRC scientists have invented. This means that our existing rugged computers will be run at much higher performance rates than ever before. It also means that we can build new computers using high-performance silicon that previously would have been impossible to deliver in a small, fan-free enclosure. That's GE Rugged!

This is all very exciting for us, and we'll be sharing more in a few months.

C2: Let's wrap up with this question: what's your key challenge?

Rubin: The biggest challenge for us is taking all of the products, technology, support and processes we have built for our military customers

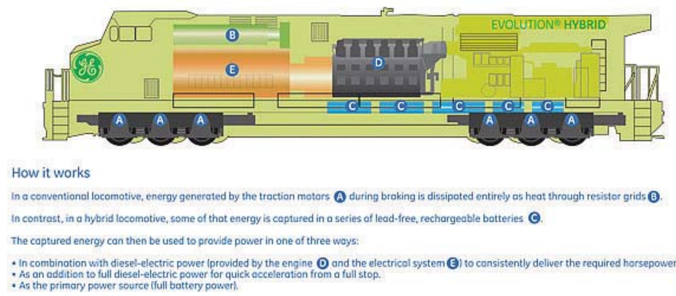

Figure 7: A GE hybrid diesel/electric locomotive relies on embedded electronics that are GE Rugged.

and packaging them in a way that we can deliver to other industries. The industrial industries we are targeting want GE Rugged—they want the military-grade rugged hardware, security features such as information assurance and anti-tamper, lifecycle support and so on, but in a different form factor, often higher volumes and lower price points. This is definitely an area where we can lean on the broader GE business to help us.

C2: Final thought?

Rubin: GE's embedded business puts the intelligence in the Industrial Internet by making machines "brilliant."

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A Disruptive Technology Goes Hollywood

By Anne Fisher, Managing Editor

Dave Duncan

Long before TI DLP® chips figured in such industrial uses as high-resolution 3D printing, security for intellectual property, medical applications including allowing medical personnel to find patients' veins accurately, or consumer use such as assigning tablets the job of movie projector, movie directors and cinematographers found the prospect of digitally wrangling light enticing.

In February Texas Instruments (TI) Fellow Larry J. Hornbeck, PhD, was awarded an Academy Award® of Merit (Oscar® statuette) for the invention of the digital micromirror device (DMD) or DLP chip. Our thanks to Dave Duncan, TI's Manager of DLP Enterprise and Cinema Display Products, who fielded questions about what led to Dr. Hornbeck's achievement and its ongoing beneficial repercussions for embedded developers. Edited excerpts follow.

EECatalog: What's most significant about Dr. Hornbeck's achievement?

Dave Duncan, TI: I think the most significant thing is that this is the first digital display technology that could ever have hoped to replace a more than 100-year-old 35mm film and really even 70mm film technology that's been used in analog exhibition of motion pictures produced and distributed by Hollywood and other international studios.

EECatalog: How did the collaboration with those on the cinema side, filmmakers and others, work?

Duncan, TI: From the very first time we took a prototype digital cinema projector to Paramount Studios into one of its theatres on the lot, and the very first time we showed this technology to filmmakers and cinematographers back [in the late 90's] Hollywood recognized, "There will be a day, and it will come sooner rather than later, that a digital display technology will overtake film." We saw this as a very, very collaborative effort between not only the motion picture studios, but also exhibition as it related to improving our technology.

The first prototype [of the DLP Cinema® technology] gave them a glimpse of the potential. Next came feedback. Typically the things they would ask us to improve would be, for example, the native capability to reproduce film-like colors and to very accurately represent what the overall contrast capability of 35mm film was at the time. [Meanwhile], the six major studios founded Digital Cinema Initiatives LLC (DCI). [This initiative] established a minimum set of requirements for the digital cinema projector as well as the server to make sure that just as with 35mm film, anytime you had a digital master, as long as you sent it out on a known format, a defined format, that it could play on any projector in the world as long as it met that requirement. This was done using our technology as the basis for that standard.

EECatalog: To what kinds of uses do filmmakers put DLP Cinema technology?

Duncan, TI: Take the ability to do digital dailies, for example. If a director of a movie is shooting scenes all day, then sends the film to the lab at night, the director gets the film back the next day, then studies the dailies from the previous day to determine what is good and not good. If it's not good of course they have to reset that entire scene and do it all over again.

After we put digital cinema projectors on location so that, in real time, directors and others could take a look at what they had captured, this created a huge efficiency gain from an overall production standpoint.

We also showed how DLP Cinema technology affords the opportunity to capture, distribute and exhibit movies at frame rates that had never been seen before (most recently with the first Hobbit movie). With film you were limited to 24 frames per second—as opposed to the higher frame rate many people have become used to with their TVs at home. Especially if a movie includes a pan from one side of the image to the other [with the 24 frames per second limit] you can get judder, or motion blur. Increasing the frame rate to 48 or 60 frames per second significantly improves the image quality by virtually eliminating motion blur.

EECatalog: What is important for embedded developers to know about DLP technology, particularly those developers concerned with time-to-market?

Duncan, TI: I understand lack of patience and time to market. [However], Dr. Hornbeck started working on the DLP chip development back in 1977, and we did not ship our first production unit until 1996, and we just got to 119,000 DLP Cinema projector systems within the last month. Whenever you are talking about an innovation like this one, it sometimes does take a long time.

The fundamental advantages of a DLP pixel are its scalability, its digital accuracy and its long-term reliability. This started as an idea in Dr. Hornbeck's mind: "What if I could digitally control light, what would that enable?" So now we have this classic example of the Sprout by HP. There was a developer out there who said, "Hey, how can I change the way people use a user interface for a PC? Well, I know what I am going to do, I am going to put a projector on top of my display monitor, I am going to put an image on the surface, and I am going to allow the users to have an entirely different experience where now they can scan objects in 3D, they can put them into a presentation, they can manipulate them however they want to do it." So now you have a totally interactive surface as opposed to the traditional type of keyboard and mouse that we have had to deal with for all these years.

There are numerous examples. We were at CES in January, and there are young professionals in China who leave school, they go to their first job and live in one of these gigantic high rises in China, and they do not want a big screen TV. Number one, they're quite expensive, they are cumbersome to get into the apartment, and it's difficult to find the space to mount them on the wall. And three months later that professional might move to another to another building. Do they really want to yank their TV off the wall and haul it around again?

So every major television manufacturer in China right now, and several in Europe, are working on laser projection TV, a very small box with ultra short throw optics. You set this on your dresser right up against the wall, and someday it will probably be embedded in your dresser, and you won't even know it's there, so when you move the dresser you will be moving the display with you. It is wireless so it can hook up to whatever network on which you have your content. You plug it in, and now you have this 110-inch HD moving to 4K image on your wall. It moves with you very easily from building to building. I was blown away by the number of them that were being shown at CES and the quality of these displays.

The Lenovo Yoga tablet 2 is another example, where you embed a little microprojector using the DLP Pico chip, which spawned from DLP Cinema chip architecture into the end of your tablet and now, if you are looking at a movie and you want to see it on a bigger screen, just turn the projector on and project it onto whatever surface you like.

EECatalog: What additional information would you like to share with embedded developers?

Duncan, TI: [That] TI has evalution module (EVM) kits that allow developers to ask, "If I can digitally control light, what kind of cool things can I go do with that?" We've done the hard part, we have created a wide range of chips: from the very small 0.2-inch diagonal used in consumer, industrial and medical applications all the way up to 1.4-inch diagonal used in 4K cinema; from low resolution to very high resolution; from high frame rates to really high frame rates. And it centers on this idea of digital manipulation of light in this very, very, very scalable and digitally accurate way.

Developers can come to ti.com/DLP, see the things that are going on, whether it is spectroscopy, lithography, 3D printing, 3D scanning, or embedded pico projection in cameras and phones and tablets.

That is the beauty of what we are doing in our Pico and Advanced Light Control groups, which is: let's let people come up with cool ideas and let's give them enough information on the Web as well as an EVM that is capable enough to let them go play and let's see what comes out of this.

Anne Fisher is managing editor of EECatalog.com. Her experience has included opportunities to cover a wide range of embedded solutions in the PICMG ecosystem as well as other technologies. Anne enjoys bringing embedded designers and developers solutions to technology challenges as described by their peers as well as insight and analysis from industry leaders. She can be reached at afisher@extensionmedia.com

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The MH70S is a half 19” modular system with up to five HDD/SSD slot cards, totaling 20 TB. For robust and safe operation, the HDD carriers can be configured in RAID 0, 1 or 5, while the carriers themselves have their own internal RAID 0, 1 and JBOD hardware configuration abilities.

The system is based on a high-performance Intel Core i7 processor supporting Intel AMT functionality with two Gigabit Ethernet interfaces. An optional TPM provides additional data safety.

An optional shelf controller complements the MH70S’ self-control and self-monitoring capabilities provided by the CPU’s board management controller.

For external communication, the system provides flexible configurations. Two of the seven slots in the system can be equipped with Ethernet interfaces and/or Ethernet switches – the latter with Power over Ethernet (PoE) functionality. For wireless communication via WLAN, UMTS, LTE, GPS or GLONASS, these slots alternatively can be used with PCI Express Mini Cards.

The MH70S offers two PSU slots for AC or DC to ensure system reliability and redundancy.

FEATURES & BENEFITS

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- Pre-configured system for storage intensive applications
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APPLICATION AREAS

Trains, buses and industrial environments

AVAILABILITY

Delivery is six to eight weeks ARO

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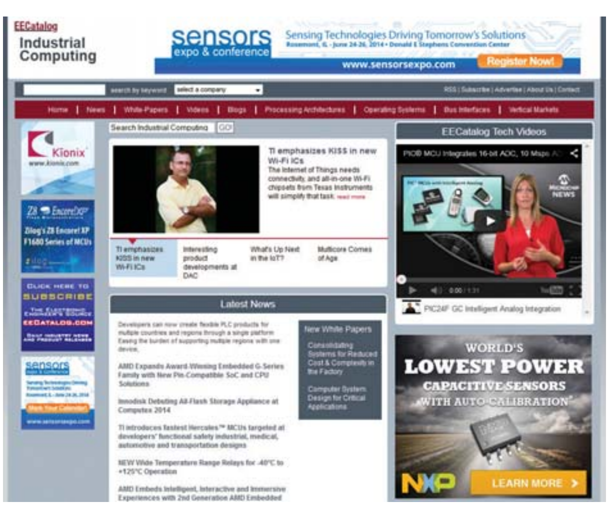

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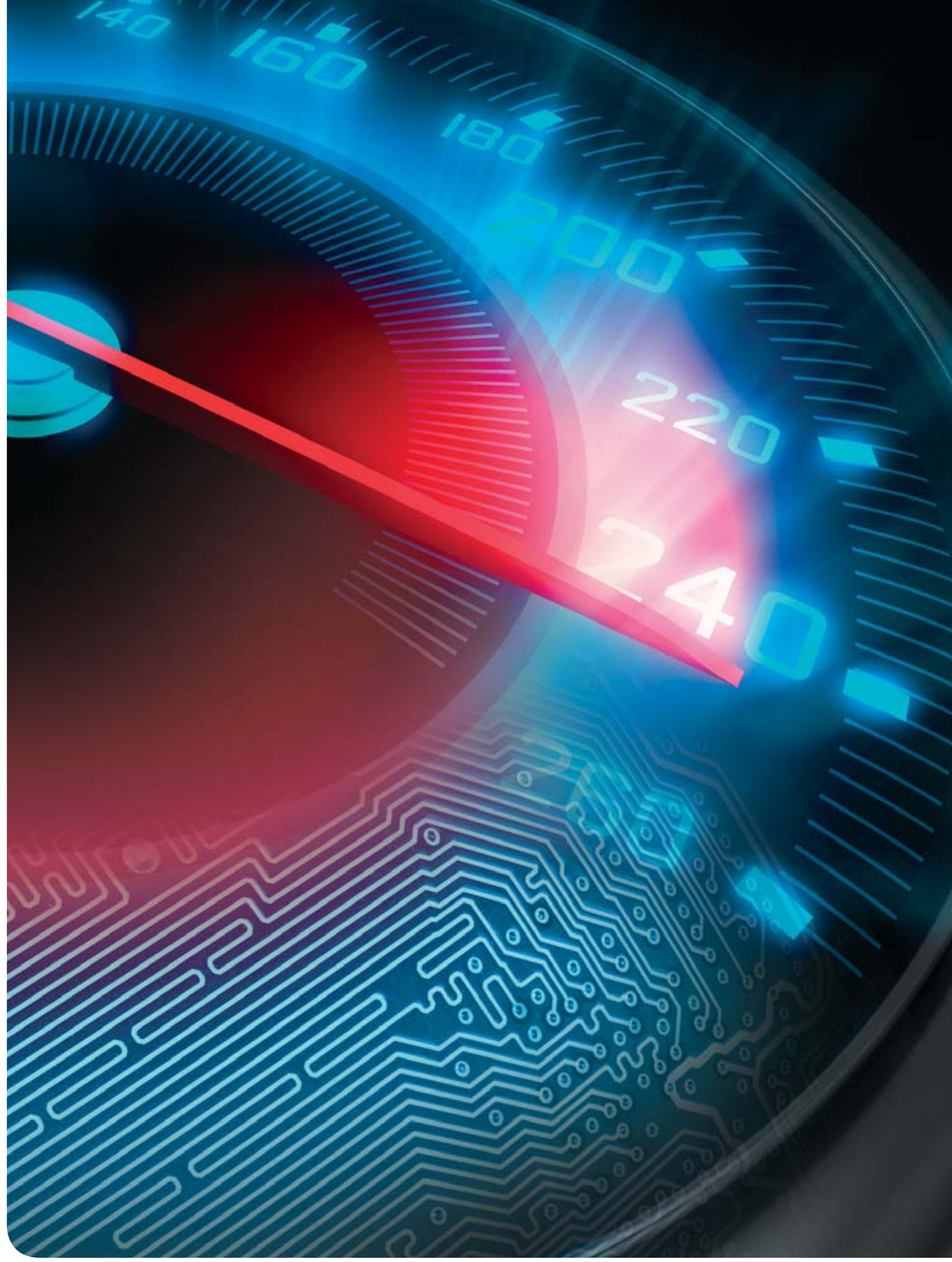

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