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**Z8F6482 Series Block Diagram**

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FROM THE EDITOR

Welcome to Embedded Systems Engineering

Guiding embedded designers on systems, technology and software.

By Chris A. Ciufo, Editor-in-Chief

You’re holding the first edition of a rare event: the launch of a new print magazine. This one is all about embedded systems, which according to every tech analyst firm on the planet, already makes up the lion’s share of the electronics market. That conclusion gets me all warm and fuzzy because I’ve for years argued that “embedded” will become dominant. As PC sales falter and telecom gets constrained by CAPEX, the race to make every device “smart” and connect it to the cloud is driving the embedded innovation explosion.

We see an opportunity to supplement our existing technology coverage of market segments like Smart Energy and Transportation with the kind of systems know-how that makes those systems smart, secure and increasingly inter-connected. Our popular EE Catalog Resource Guides (available in print and on nearly 30 dedicated digital channel) will continue to provide both editor-written and editor-audited technical articles giving you insight on hardware, software and systems design as well as sponsored literature to help our readers make design decisions.

What about the death of print media, you ask? Our concept for ESE magazine came from a napkin-like brainstorming session. Devs and designers still like to thumb through paper and discover things they didn’t know existed. We’ll publish six issues of Embedded Systems Engineering each year loaded with technical articles. In addition, our digital channels and blogs will publish hundreds more useful articles, columns, tips and guest editorials to help you evolve your own designs and grow your knowledge (and career).

Embedded is where the market is at. Embedded Systems Engineering will help you get there. Thanks for reading. Please drop me a note with suggestions.

Chris A. Ciufo, Editor-in-Chief
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Product Showcases

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01. Semiconductor Industry Posts Record Sales in 2013

Global sales increase 4.8 Percent in 2013, reaching highest-ever total of $305.6 Billion

The Semiconductor Industry Association (SIA) announced that worldwide semiconductor sales for 2013 reached $305.6 billion, the industry’s highest-ever annual total and an increase of 4.8 percent from the 2012 total of $291.6 billion. Global sales for the month of December 2013 reached $26.6 billion, marking the strongest December on record, while December sales in the Americas increased 17.3 percent year-over-year. Fourth quarter global sales of $79.9 billion were 7.7 percent higher than the total of $74.2 billion from the fourth quarter of 2012. Total sales for the year narrowly exceeded expectations from the World Semiconductor Trade Statistics (WSTS) organization’s industry forecast. All monthly sales numbers are compiled by WSTS and represent a three-month moving average.

02. Global Production of Electric Vehicles to Surge by 67 Percent This Year

Driven by tighter emission standards in Europe, worldwide production of electric vehicles (EVs) will soar by 67 percent this year, according to IHS Automotive, driven by Polk.

The huge increase in the EV market this year contrasts with the 3.6 percent rise in global manufacturing of all motor vehicles expected in 2014.

03. After a Strong December, LCD Panel Market to Moderate in Q1

The market for large-sized liquid-crystal display (LCD) panels is set for a moderate seasonal decline in the first quarter after a busy end-of-year in 2013 that saw record shipments for TV and tablet panels, according to a new report from IHS Technology.

04. Tablet Processor Chip Market to Surge by 23 Percent This Year, Attracting Intel and Chinese Rivals

Strong growth in the processor market for tablet devices this year and beyond will draw increasing competition from suppliers eager to throw their hat into the ring, including the likes of giant chip-maker Intel, according to a new report from IHS Technology (NYSE: IHS).

05. 4G Smartphone Market in China Set for Explosive 1,500 Percent Growth This Year

China’s domestic market for 4G smartphones is poised for a massive liftoff this year as shipments grow sixteenfold from 2013 levels, according to a new report from IHS Technology (NYSE: IHS).

Shipments in 2014 of 4G smartphones within China are forecast to reach 72.4 million units, up nearly 1,500 percent from just 4.6 million last year, with the market expected to take off after the second half. It will be the first big year for 4G smartphones in only its second year in the country, up from a practically nonexistent base two years ago.

For the next few years the 4G smartphone market in China will see unstoppable growth, doubling in shipments next year to 144.1 million units, rising another 53 percent to 219.8 million, and then ending 2017 at 298.5 million units. The findings are contained in the report “China Smartphone Market Enters 4G Era,” from the China Electronics Supply Chains service of IHS.

06. Top Healthcare Technology Trend Predictions for 2014

Healthcare expenditure containment continues to be the main focus of healthcare systems globally. However, the key question facing healthcare institutions is whether this will be done through short term cost cutting or through investment in long-term solutions. Healthcare funding uncertainties plagued a number of developed markets in 2013. Declining reimbursement across North America and Western Europe has resulted in deferred spending and a shift to lower cost, lower functionality devices in some instances. IHS predicts that innovative product development and streamlining procurement initiatives will dominate the medical devices landscape in 2014, in an effort to reduce spiraling healthcare expenditure.

07. Apple and Samsung Lord Over Field Once Again as Top OEMs in Semiconductor Spending for 2013

Apple and Samsung remained the world’s largest buyers of semiconductor chips in 2013, but the intensifying battle between the two for the hearts and minds of consumers in their product offerings could presage another mighty showdown this year for the top ranking, according to a new report from IHS Technology (NYSE: IHS).

Combined, the two claimed about 14 percent of total spending in 2013, well ahead of other prominent chip buyers. Rounding out the Top 5 are Hewlett-Packard in third place, with $10.1 billion in spending; Lenovo in fourth, with $9.2 billion; and Dell in fifth, with $7.7 billion. The rest of the Top 10 includes Cisco Systems, Sony, Huawei Technologies, Panasonic and Toshiba.

08. Mobile messaging security market up 70% in 2013 as carriers step up battle against spam, threats

Market research firm Infonetics Research released excerpts from its latest SMS/MMS Security Gateways, market size and forecasts report, which tracks short message service (SMS) and multimedia messaging service (MMS) security hardware and software, such as SMS firewalls and mobile messaging security platforms.

“The popularity of SMS and MMS has soared over the last decade, but carriers around the globe are just now beginning to seriously evaluate and deploy mobile messaging security solutions, forced by economic, regulatory, and attack conditions,” notes Jeff Wilson, principal analyst for security at Infonetics Research.

09. One in Three Commercial Fleet Telematics Units Shipped Based on Consumer Smartphone Platforms by 2018, According to ABI Research

With today’s mobile and cloud-based technology, commercial fleets no longer need to fit expensive hardware on their new trucks and the availability of consumer mobile devices with increasingly sophisticated capabilities means that smaller fleets are embracing commercial telematics.
Are You Taking Embedded Security Seriously?

By Alan Grau, Icon Labs

A lock with the key still in it isn’t much of a solution. Sadly, the security in many embedded devices isn’t much better.

At the gym last week I noticed a locker secured with a padlock but with the key still in the lock. One of the assumptions of locking something up is that there is something worth protecting. If the contents of the locker weren’t worth protecting, then don’t bother with the lock. But if you are going to bother with a lock, or with adding security to your embedded device, you might as well make sure the security will work. A lock with the key still in it isn’t much of a solution. Sadly, the security in many embedded devices isn’t much better.

Many embedded devices have been built with very little, if any security. Too often what security is provided is insufficient. In June 2013, ICS-CERT (Industrial Control Systems Cyber Emergency Response Team) published a list with more than 300 medical devices from approximately 40 vendors that used hard-coded passwords, almost the literal equivalent of leaving the key in the lock.

Other embedded devices are using out-of-date crypto standards. For example, keyless remote vehicle entry systems utilize encrypted RFID signals. Most implementations use a 40-bit encrypt key. When the standard was first introduced in the 1990s, 40-bit encryption keys would take days to crack, but not today. A google search of “keyless vehicle entry systems hacked” turns up a number of articles describing how thieves are exploiting this weakness to steal cars.

FOR the complete blog visit: http://eecatalog.com/grau/2014/02/04/are-you-taking-embedded-security-seriously-2/

IHS Embedded Ranks VME/VPX Suppliers

By Chris A. Ciufio, Editor-and-Chief

With vendor-supplied data, analyst firm IHS ranks the largest embedded suppliers in the VME/VPX market.

The Embedded Tech Trends insider conference in Phoenix, IHS senior analyst Toby Colquhoun revealed the top suppliers in the VME and VPX market space for the year ended 2012 (the latest data available). The conference is sponsored by the standards organization VITA that’s responsible for these open standards. It’s always a challenge to get quantitative data on this niche market which primarily services the world’s rugged military and aerospace markets with harsh environment modules, connectors and systems.

GE Intelligent Platforms is the largest supplier when VME, VPX and systems are combined, followed by: Curtiss-Wright Controls Defense Systems, Mercury Computer, Kontron, and Emerson Network Power (Figure 1, with apologies for the quality).

Toby also indicated that the VME market is shrinking, as legacy designs migrate to VPX modules and systems. In the VPX-only market for modules and systems, the ranking changes to:

1. Curtiss-Wright at 38 percent
2. GE Intelligent Platforms at 19 percent

This ranking is consistent with my own expectations (and CW’s recent press releases proclaiming themselves as number one). Interestingly, when I asked the question about small form factor systems like those from these same suppliers, plus ADLINK, Advantech, MEN Mikro and others, Toby responded that IHS doesn’t see that these kinds of rugged systems are encroaching on the VME/VPX market. I disagree, but can’t quantify that just yet.

We’ll update this data once we receive the actual presentation later today.

FOR the complete blog visit: http://eecatalog.com/caciufio/2014/01/20/ihs-embedded-ranks-vmevpix-suppliers/
Form Factor Decisions: The Application and Deployed Environment (Part 2)

By Mark Littlefield

Part 1 of this four-part discussion on form factors is followed here with the first four key “vectors” necessary to solidify the choice of a board’s form factor.

In part 1 of this series (found http://eecatalog.com/littlefield/2013/08/08/part-one-form-factor-decisions-not-getting-any-easier/) I discussed the 10 dimensions involved in deciding on an embedded system form factor. In this post I will look at the first four vectors that drive the system engineering form factor decision process:

• The computational power needed by the target application
• The I/O needs of the application
• The size, weight, and power constraints (SWaP) of the deployed platform
• And the characteristics of the deployed environment.

These tend to be relatively “fixed” requirements that, when understood, can dramatically reduce the form factor space. Some of these vectors can be characterized and understood by analysis. Others, however, require different approaches.

FOR the complete blog visit: http://eecatalog.com/littlefield/2014/01/06/part-2-form-factor-decisions-the-application-and-deployed-environment/

MEMS: An Enabler of the Next Internet Revolution

By Howard Wisniowski, President of HW Marketing Group

The next internet revolution is shaping up and MEMS is poised to play an important role. Commonly referred to as the Internet of Things (IoT) or Machine to Machine (M2M) communications, this revolution consists primarily of machines talking to one another, with computer-connected humans observing, analyzing and acting upon the resulting ‘big data’ explosion it produces. While the first internet/web revolution changed the world profoundly, the disruptive nature of MEMS, M2M and the Internet of Things has the potential to change it even more as the big data machine will no longer be dependent on human data entry. The internet traffic will be automatically generated by millions of ‘things’ from which we can retool large parts of the world for better efficiency, security and environmental responsibility.

The enabling qualities of MEMS sensors quickly come to mind since they are increasingly becoming cheap, plentiful and can communicate, either directly with the internet or with internet-connected devices. Almost anything to which you can attach a sensor — a football helmet, an automobile, a smartphone, a cow in a field, a container on a cargo vessel, the air-conditioning unit in your office, a lamppost in the street — can become a node in the Internet of Things. Be it on location, altitude, velocity, temperature, illumination, motion, power, humidity, blood sugar, air quality, soil moisture… you name it, MEMS-based sensors will play an important role in gathering and/or disseminating data from millions of devices.

Deeper into the signal chain, however, is another class of MEMS devices that is evolving and will have a profound impact. At the heart of all the “connected” devices will be a component that provides the timing that enables all communication to occur.

FOR the complete blog visit: http://semimd.com/mems-industry-group-blog/2013/12/09/mems-an-enabler-of-the-next-internet-revolution/
SoC FPGA Relies on Many Cores & 14 nm Tri-Gate Process

Alterna’s multicore FPGA uses Intel’s tri-gate (FinFET) 14 nm 3D process technology to combine logic, four ARM A53 cores and OpenCL as a heterogeneous SoC replacement.

At the core of Alterna’s recent Stratix 10 announcement is...multiple cores. Four ARM Cortex-A53s to be exact, plus a bunch of DSP blocks, more logic than ever before done by the company, double the on-chip clock rate and software designed to create a multicore system instead of just a dense FPGA. In effect, it’s a system-on-chip (SoC) that bests the company's recent Arria 10 SoC.

But also at the core of the 2014 next-gen FPGA family is Intel’s tri-gate (FinFET) 14 nm process technology, to which Alterna has the exclusive FPGA rights for 12 years. It’s Intel’s tri-gate transistors that give Alterna the edge—at least on paper—in the war of high density FPGAs. Details on Alterna’s Stratix 10 (the follow-on FPGA to the Stratix V) are still scarce, though the company’s second pre-announcement added more details and we can guess at others.

The new multicore Stratix 10 FPGA SoC will tape out in 2014 and may possibly ship by late 2014. Let’s take a look at some of the elements that make up the Stratix 10’s performance goals.

TRI-GATE’S SECRET SAUCE

Altera is relying heavily on four factors to achieve the aggressive specs for Stratix 10: a refined architecture, the ARM Cortex A53, software tools such as OpenCL and Intel’s tri-gate 14 nm process.

Intel has consistently battled Moore’s Law through new process innovations. Following two-dimensional high K (dielectric) metal process improvements at 45 nm in 2007, Intel unveiled 3D transistors in 2011 in 22 nm feature size. As oxide thickness and transistor dimensions approach mere Angstroms, the company essentially made transistors “smaller” by stacking them in layers and wrapping the silicon channel with three gates instead of two. This allows more transistors per square nanometer by using the Z axis, and they’re smaller and more power efficient. The concept of a non-planar double-gate transistor with a fin wrapped around the channel is called a “finFET,” although Intel calls theirs “tri-gate” (Figure 1).

In early 2013, Intel and Alterna inked a deal that allowed Alterna to become the only FPGA company with access to Intel’s 14 nm tri-gate process. Alterna’s CEO John Daane said at the time that he believed Intel was two to four years ahead of the competition. (This is debatable as TSMC moves from 20 nm to 16 nm.) Intel is already producing 22 nm 4th generation Intel® Core™ and Intel® Xeon® processors (codename Haswell) processors on tri-gate and a 14 nm, 5th generation Intel® Core™ processor (codename Broadwell) is scheduled for production in 2014.

Despite a recent delay that necessitated design rule changes to Intel’s 14 nm process, Alterna as an Intel foundry customer will certainly follow shortly after Intel’s production of the Broadwell microarchitecture-based processors. According to Chris Balough, Alterna’s senior director of SoC product marketing, design software for the Stratix V will be available Q1 2014 and first silicon will tape out sometime in 2014.

“UNIMAGINABLE” PERFORMANCE

In June and in November, Alterna began predicting some pretty big numbers for Stratix 10...so much so that the nomenclature leaped from Stratix V (available now) to Stratix 10. The company is making what Balough called a “hyperbolic claim, something we never guessed was possible,” he told me. There will be a 2x increase (from 28 nm) in logic fabric speed to over 1 GHz. Even though density increases, the SoC device will also achieve a 70 percent power savings with a target 4x. Other technology targets are shown in Table 1.

There is credibility in these claims, albeit based upon scaling factors. The new, in-production Arria 10 SoC is based upon TSMC’s 20 nm process and is 15 percent faster than Arria V, consumes 40 percent less power and boasts a 50 percent processor system improvement. For Stratix 10, the magic again is Intel’s 14 nm tri-gate process as described in the whitepaper “The Breakthrough

Altera has provided no details yet on architecture other than the notional marketing chart shown in Figure 2. Fundamentally, Stratix 10 processing will take place in FPGA gates, four ARM Cortex-A53 processors and a series of DSP blocks. Software tools meld it all together into a powerful one-chip system.

**DSP BLOCKS AND ARM CORES**

Current-generation Stratix V devices contain two columns of DSP blocks surrounded by constellations of logic array blocks. Each DSP block (Figure 3) can be configured for up to eight 9 x 9 bit multipliers, four 18 x 18 bit multipliers and one 36 x 36 bit multiplier. These DSP blocks run at 333 MHz and provide data throughput performance of 2.67 giga-MACs per block. The largest Stratix V device (EP1S80) has 22 DSP blocks.

With the forecasted 1 GHz fabric on Stratix 10 over Stratix V’s 333 MHz, one might expect a 3x performance increase with no logic changes. However, Altera’s Balough told me they’re expecting a 6x throughput increase for Stratix 10 to “greater than 10 TFLOPs.” It’s entirely likely the number of DSP blocks will double, RAM block sizes will increase and there will be some fine tuning within the blocks and routing fabric. However, it’s also possible the 6x claim is taking into account other FPGA resources for data movement and manipulation such as the ARM processors.

An FPGA’s DSP sub-systems are a major reason FPGAs are chosen for high-performance algorithms like video CODECs or data-plane processing. On the Stratix 10, there are also the four ARM Cortex-A53 processors. Altera press materials cite an 8x throughput improvement over 28 nm FPGAs, and Altera says that ARM claims it’s the highest power efficiency of any 64-bit processor. That’s probably not hard to argue considering ARM’s leadership in mobile and low-power devices...and Intel’s struggle to catch up.

The four Cortex-A53 cores shown in Figure 4 are members of ARM’s Cortex-A50 series announced in 2012 and are based on the ARMv8 64-bit architecture. The A53 chosen for Stratix 10 is the “little brother” to the A57, ARM’s single-threaded, deep pipeline monster targeting servers. Both devices are designed for gigahertz performance in heterogeneous SoCs. For example, Stratix 10’s A53s will target applications that offload x86 host processors, while AMD’s HieroFalcon server accelerator 64-bit SoC (2H 2014) uses the Cortex-A57 to complement AMD’s on-chip x86.

Stratix 10’s A53s are software compatible with previous generation 32-bit ARM Cortex-A9s in Altera Cyclone, Arria and Stratix devices. This allows design sockets to upgrade to the latest FPGAs while migrating forward operating systems, unmodified software and IP cores (Figure 5). The A53 can access up to 256 TB of memory with ECC for on-core L1/L2 caches; both features pinpoint data center and high-end heterogeneous computing applications. To fully capitalize on Stratix 10’s logic, DSP and A53 resource elements, the company is planning a suite of heterogeneous-focused tools.

**SWEET TOOL SUITES**

Altera’s Chris Balough asserts that “all of Stratix 10’s processing elements are compelling enough by themselves,” but the “ unimaginable performance” comes into play when they work together as a system. Altera is counting on OpenCL and the SoC Embedded Design Suite (EDS) to capitalize on the FPGA’s heterogeneous elements.

The company has endorsed C-based design entry using OpenCL for several years via the SDK for OpenCL product. First demoed by Altera at SuperComputing 2012, the OpenCL design flow allows designers to work in C and easily mix logic and on-chip resources into heterogeneous multicore architectures. The high-level design flow alleviates the typical RTL coding required for most FPGA tasks. It also mimics the way embedded developers mix and match processing resources at the board or system level.

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Table 1: Stratix 10 performance targets. (Source: Altera.)
OpenCL code is also portable and lets designers load-level or performance-tune applications to take advantage of the massively parallel nature of FPGAs and the Cortex-A53 CPUs. In October of this year, Altera announced the SDK for OpenCL is conformant to the OpenCL 1.0 standard and is listed on the Khronos Group list of conformant products. This means that Altera can “provide a validated cross-platform programming environment” designed to accelerate algorithms at significantly lower power versus other cross compiler alternatives.

Practically speaking, OpenCL allows Stratix 10 designers to port or create hardware accelerators to take advantage of the FPGA’s parallelism. This has always been possible when coding in RTL but not necessarily practical and usually not easily portable. The OpenCL SDK is complemented by EDS which provides FPGA-adaptive debug. Altera’s Chris Balough describes EDS as “a native multicore debug environment with intrinsic FPGA debug capabilities built in.” EDS supports real-time, in-system, whole-chip debug and visualization, including the ARM Cortex-A53 cores. That’s because EDS includes Altera’s existing DS-5 Altera Edition software, ARM’s own development tool that’s been tailored for Altera FPGA devices.

Both the OpenCL SDK and EDS software suites exist today for production devices, and will soon be released supporting the Stratix 10 so lead customers and early adopters can start their designs.

CONCLUSIONS: ALTERA’S DESIGN TARGETS
We’ve written quite a bit about Altera’s burgeoning roadmap over the past twelve months. During an interview in July 2012 with Brad Howe, Altera’s senior VP of R&D, he talked about the need for FPGAs to evolve past their growing complexity and focus instead on “silicon convergence” (http://eecatalog.com/fpga/2012/07/17/fpgas-the-best-of-both-worlds-until-theyre-not/). He was of course referring not only to heterogeneous FPGA SoCs, but also on reducing design complexity with OpenCL.

QuickAssist Technology Capitalizes on FPGA Resources
Altera was the first FPGA company on record to support Intel’s QuickAssist technology, a set of instructions and APIs that seek to offload host CPU instructions to a co-processor like an FPGA. XtremeData was the board vendor who demoed it at the 2008 Intel Developers Forum with a Xeon and Mathworks’ Simulink graphical block diagramming software.

Altera’s Stratix 10, with faster transceivers, DSP blocks and 1 GHz fabric, is likely to be a favorite co-processor for Intel host CPUs like the latest 4th Generation Core devices (code named Haswell) or Intel’s next-generation 14 nm tri-gate Broadwell CPUs. According to Intel, QuickAssist (http://www.intel.com/content/www/us/en/io/quickassist-technology/quickassist-technology-developer.html) is ideal for computational workloads including cryptography, data compression and pattern matching—all applications that are algorithmically “heavy” and can take advantage of an FPGA’s parallelism via mixed resources.

In the case of Altera’s Stratix 10 next-gen devices, CPU offload via QuickAssist could also utilize high-level language OpenCL to construct heterogeneous “hardware macros” which balance workloads between the FPGA fabric, DSP blocks and the decision-making capability of the ARM Cortex-A53. All of these resources, of course, work as an accelerator sub-system to Intel’s Xeon, Core and now the newest Rangeley Atom CPUs—all of which contain Intel QuickAssist Technology.

Figure 3: Intel’s tri-gate transistors propagate Moore’s Law, increase silicon density, and reduce power.
Figure 4: Stratix 10 contains four Cortex-A53 cores, ARM’s most impressive multi-threaded 64-bit core.
Stratix 10, with its "unimaginable performance" made possible by Intel’s 14 nm tri-gate process, epitomizes the future of big density FPGAs. "It was an explicit choice to make [Stratix 10] a heterogeneous computing platform," said Altera’s Chris Balough.

We’re anxious to see the company release details on the architecture, cite power estimates based upon notional reference designs and detail more of the specs. As we went to press, Altera revealed some data on Stratix 10’s transceivers (4x bandwidth and 28 Gbps backplane switching), and indicated that the device is 3D-capable for packaging with ASSPs and memories.

Also, it will be interesting to see if Altera targets Big Data applications with Stratix 10 as I had predicted in June 2013 (“Does Altera have ‘Big Data’ Communications on the Brain?” http://ecatalog.com/caciufo/2013/06/05/a-slew-of-recent-altera-high-performance-announcements-over-the-last-three-months-can-only-mean-one-thing-the-company-is-targeting-big-data-in-a-big-way/#comment-20464 ). The company’s string of acquisitions and posturing sure points that way.

OpenCL allows Stratix 10 designers to port or create hardware accelerators to take advantage of the FPGA’s parallelism.

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.
Automotive Ethernet: No Simple Answers

Industry leaders speak out on the status of automotive Ethernet and where the technology needs to go.

By Cheryl Coupé, Managing Editor

As Microchip Technology’s Henry Muyshondt states, “Ethernet means different things to different people.” And that makes a discussion of the adoption of Ethernet in automotive applications tricky. Along with Muyshondt, senior marketing manager for the Automotive Information Systems Division of Microchip Technology, Inc., we have Armin Lichtblau, business development director for the Automotive Network Design at Mentor Graphics (Deutschland); Joel Hoffman, automotive strategist for Intel’s expanding Automotive Solutions Division; and Nick DiFiore, director of the Automotive Segment for Xilinx. Many thanks to our panel for their thought-provoking responses!

Henry Muyshondt, Microchip

Armin Lichtblau, Mentor Graphics

Joel Hoffman, Intel

Nick DiFiore, Xilinx

EECatalog: What’s your view of the status of Ethernet adoption in automotive applications?

Henry Muyshondt, Microchip: For streaming data within the vehicle, the automotive industry has already pretty much settled on the MOST standard (Media Oriented Systems Transport). Over the last 13 years, it has come to be used in more than 150 automobile models already on the road, from most of the major car makers, in all regions of the world. There are more than 100 million MOST devices in use, as multiple devices are used in each vehicle. This technology can handle both Ethernet frames, as well as streaming information, all running in parallel. The higher-layer protocols used in the IT industry can communicate over the MOST standard without needing any changes, other than at the low-level link layer. Ethernet frames are sent unmodified, and other channels are available to transport audio and video data without overhead.

In terms of the actual Ethernet physical layer, it is not well suited for automotive applications due to electromagnetic compatibility issues as well as the challenges associated with running standard Ethernet cabling within the vehicle. There are proprietary technologies, such as Broadcom’s BroadR-Reach that could be applied, but those are not really standard Ethernet and at this point have not received the wide adoption among carmakers that some in the industry press would suggest. There are many challenges that would need to be solved, in order to implement a low-cost, standards-based Ethernet solution in automobiles, and it will be several years before the current IEEE efforts toward defining a Gigabit physical layer for automobiles become a reality.

In short, Ethernet-style frames are definitely seeing increased use in automotive applications. The Ethernet physical layer, not so much.

Armin Lichtblau, Mentor Graphics: Particularly for new generation E/E designs and often AUTOSAR systems, Ethernet in the car is a requirement. The Ethernet communication is required as diagnostics over Ethernet to achieve high-speed, end-of-line programming in one use case. The other use case is the adoption of high-speed applications in the car environment, e.g., for video signal processing on safety and active safety systems (collision camera, etc.).

Joel Hoffman, Intel: Ethernet adoption is occurring slowly in automotive.
In short, Ethernet-style frames are definitely seeing increased use in automotive applications. The Ethernet physical layer, not so much.

These issues existed in the tech and enterprise segments as well, when Token-Ring, Asynchronous Transfer Mode (ATM) and other complex designs claimed technical advantages until more advanced silicon and software were created for the broader Ethernet market. If these issues had lingered, we would not have the cost-effective enterprise cloud and connectivity that we have today.

Nick DiFiore, Xilinx: Ethernet for automotive applications is rapidly growing among automotive OEMs to meet the growing bandwidth demands for new in-car audio and video (A/V) features. Many automobile vendors are planning to roll out Ethernet-based infotainment and advanced driver assist systems (ADAS) products in their 2015-2017 models. As a result, several high-profile automotive OEMs including GM, BMW and Hyundai have joined the AVnu Alliance—an industry forum dedicated to the advancement of professional-quality audio video in markets that include automotive, professional AV and consumer electronics. Xilinx is one of the founders of the AVnu Alliance.

EECatalog: Where does the technology need to go to cement Ethernet’s role in the car?

Muyshondt, Microchip: If by Ethernet you mean packet-based communication technology, that role is pretty well cemented in the car for future applications, as mentioned above. The cement is still hardening, but there is no doubt that for inter-domain communication, both inside and outside the vehicle, packet-based communication is very relevant.

Much remains to be seen about what is implemented at the physical level, to transport these packets of information. So far, there are more than 150 vehicle models that have standardized on MOST technology for their high-speed network. MOST, in turn, has been enhanced to include packet communications and a dedicated Ethernet packet channel that can move unmodified Ethernet frames. We expect Ethernet to be used for some types of communication within the vehicle, using the existing MOST infrastructure. Additionally, a next-generation, multi-gigabit version of the MOST standard is already being developed for future applications. Even if packet communication is used for all in-vehicle applications, the MOST technology’s full bandwidth can be allocated to Ethernet-style communication, providing an automotive-proven physical layer that also has the flexibility to allow streaming communication in parallel with the packet-based channels.

The MOST standard has already cemented itself with companies such as General Motors, Volkswagen and Toyota, along with most of the other major car makers of the world. These are large-volume manufacturers that have already proven the MOST technology’s cost-effectiveness for even midrange to low-end vehicles. Additionally, the MOST Ethernet Packet channel is helping car makers implement Ethernet-style communications in vehicles.

Ethernet-style communications are already in place, while the Ethernet physical layer really isn’t being used in vehicles.

Lichtblau, Mentor Graphics: Ethernet stacks need to be implemented in the Embedded Basic software stack which is used as the central operating platform in the car ECUs. The tooling provided for the ECU development needs to be set up to configure and test the Ethernet components. The IP communication protocol needs to be adjusted with higher level protocols to accommodate the automotive requirements.

Hoffman, Intel: OEMs need to take a leadership position in solving any remaining technical issues and pulling their supply chain into the ecosystem. This begins with audio systems implementing audio-video bridging (AVB), and extends to other deterministic control systems in the vehicle. While there are risks with implementing any new technology, automakers have great influence in stimulating the development of related software that will be needed. For the first cycle or two there may not be significant savings; however, the first adopter will gain the most in the end through reduced development costs, reduced equipment costs and long-term vehicle fuel savings due to vehicle weight reduction.

DiFiore, Xilinx: There are two main issues:

1. 1Gbps physical transport in automotive environments. There’s a need for a low-cost, single, unshielded twisted-pair (UTP) solution that meets automotive EMC requirements. This need is currently met by Broadcom’s Broad-R-Reach technology for 100Mbps Ethernet networks. The industry still needs an affordable 1Gbps UTP solution to really cement use of Ethernet in automotive applications, especially for A/V uses. Broadcom and other Ethernet vendors are working on technology to meet the 1Gbps requirement.

2. Guaranteed quality of service (QOS) over Ethernet for reliable, deterministic, real-time data delivery and audio/video streaming over Ethernet in a car. This need is not fully satisfied by cur-
current IEEE Ethernet standards. However standards dealing with bandwidth reservation, time synchronization and packet prioritization are emerging and the AVnu Alliance is developing ways of adapting these standards for automotive needs. Many automotive OEMs are currently evaluating Ethernet extensions against their list of requirements. At this point, it’s not clear if OEMs will agree upon a complete, standardized Ethernet stack or if different OEMs will simply adopt variants of Ethernet AVB.

EECatalog: What are the challenges you expect to address?

Muyshondt, Microchip: The biggest challenge is to have the right system, at the right point in time, at the right cost point. The networking infrastructure inside vehicles has much different requirements than the typical IT infrastructure, in terms of robustness and surviving in a harsh environment. Microchip is a leader in both consumer and automotive applications, and I can tell you that it is not easy to simply take a consumer device and harden it for automotive applications. The device has to start out with the design goal of being used in automotive applications.

Bandwidth costs money. You can either spend that money on the physical connection, or you spend it on bigger processors with more computing capabilities. The challenge is to balance all sides of the equation to obtain the optimum system. This requires participation by the people designing the system. Carmakers have to be involved from the ground up in specifying the various parameters, including how the system will be supported after it rolls off the assembly line, and for many years after it rolls away from the dealership. Only carmakers and their suppliers can properly assess the correct trade-offs among the various competing objectives of a networking and communication system. Their timeframes for choosing a technology have to look five years or even a decade into the future, in order to select the appropriate technology to use. Carmakers have to be technology decision-makers, and not just the users of what other industries may provide.

Infrastructure, such as a networking system, doesn’t provide a lot of differentiation between cars. As such, it is in everyone’s best interest to use common “plumbing” to move the data behind the dashboard. Carmakers need to cooperate with each other on a technology they can truly influence, rather than relying on devices primarily built for other industries that have much higher volumes, and therefore much higher influence, than the automotive industry. Their products have very long life cycles, measured in dozens of years rather than a few months, and therefore their choices need to have built-in reliability and robustness. They also have to have the confidence that the actual devices they select to implement a technology will still be manufactured more than a decade later, when the consumer and IT devices of today are but a long-forgotten memory.

Ethernet-style communications can help address some of these challenges, alongside streaming technologies such as the MOST standard. The Ethernet physical layer, on the other hand, just isn’t well suited for automobiles.

Lichtblau, Mentor Graphics: Mentor is committed to provide an Ethernet stack as part of their AUTOSAR solution and will fully support Ethernet in cars and diagnostics over Ethernet with their Embedded SW AUTOSAR stack as well as the AUTOSAR tooling.

Hoffman, Intel: Intel believes in standards and has benefited most when standards are widely adopted. Our participation in automotive forums including AVnu Alliance (avnu.org), GENIVI Alliance (genivi.org), Wi-Fi Alliance (wi-fi.org) and others bring the best of the ecosystem together to agree on common methods for solving common problems. Collaboration with these groups allows Intel to produce silicon solutions such as the Intel® Ethernet Controller I21X family with support for AVB. Intel also develops proof point technologies to jump start the industry including reference implementations such as Open AVB (https://github.com/intel-ethernet/Open-AVB).

DiFiore, Xilinx: Xilinx solutions already address Ethernet QoS challenges and the company has worked with Digital Design Corporation (DDC, a Xilinx Alliance Program member) to develop a complete Ethernet AVB solution called EAVB for automotive applications for use with Xilinx FPGAs and the Xilinx Zynq All Programmable SoC. Ethernet AVB implementations on Xilinx All Programmable platforms allow our customers to develop and field system designs well ahead of their competitors and to react quickly as the automotive uses of Ethernet and the related standards evolve and grow.

Cheryl Berglund Coupé is managing editor of EE_Catalog.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.
Growth in U.S. Rail Offers New Opportunities for Embedded System Designers

Embedded system designers with expertise in defense, aerospace, industrial or automotive applications can transfer the harsh-environment, high-vibration aspects of those safety-critical market experiences into the railway sector.

By Barbara Schmitz, MEN Mikro Elektronik

A variety of conditions have affected the evolution of embedded computing technology in rail applications—including market demand, standards organizations, equipment vendors and economics. Historically, European vendors of rail equipment might have pushed the envelope of embedded technology a little harder and further because of the greater emphasis on passenger service there. But anticipated growth for U.S. passenger rail service offers new opportunities for embedded system designers to implement safety and control applications for high-speed or light-rail systems.

ADAPTING TO A CHANGING WORLD
Despite America’s affinity for the automobile, the combination of metropolitan highway congestion and increased door-to-door times associated with air travel (upwards of three hours for a one-hour flight), make high-speed rail travel a viable, cost-effective alternative for trips of two to four hours duration.

The American Recovery and Reinvestment Act of 2009 (ARRA), which allocated $8 billion for high-speed rail projects, has helped to promote initiatives for new routes in the U.S. One area of focus includes the Northeast Corridor between Boston, New York, Philadelphia, Baltimore and Washington, where distances are relatively short and demand is high. And in California, that state’s high-speed rail authority is developing an 800-mile, high-speed train system connecting the state’s major urban centers, including the Bay Area, Sacramento, Fresno, Los Angeles and San Diego. Other targeted opportunities include Texas, the Midwest and Northwest.

MUTLIPLE AVENUES FOR TECHNICAL ADVANCES
The potential for embedded system applications covers a broad spectrum—from the rolling stock itself to the associated modern power supply and signal technology infrastructure.

At the most fundamental level—track construction—there is a need for precision equipment to ensure accurate installation of rails within very specific tolerances, to prevent problems from being exaggerated by higher train speeds. Even after initial installation, monitoring systems need to ensure that the effects of wear and stress don’t compromise wheel flange and rail-gage face geometry that could lead to flange-climb derailments. (Half of all derailments are attributed to faulty tracks or equipment.)

From an operational perspective, there are multiple needs for wireless communications systems designed to prevent switching mistakes, control excessive speed and automatically enforce fail-safe control in the event of human error. The Federal Railroad Administration (FRA) is encouraging the industry to implement Intelligent Railroad Systems—including new sensor, computer and digital communications technologies—as integrated solutions that will compound the benefits for train control, braking systems, grade crossing safety and defect detection. Such advanced train control systems are geared to allow a higher concentration of...
rail equipment to operate safely within a given track infrastructure.

Finally, at the passenger service level, wireless communications applications can upgrade infotainment systems for real-time rail scheduling, news feeds and entertainment programming during transit.

DELIVERING PRECISION IN A ROUGH ENVIRONMENT

Although manufacturers situated in or serving overseas markets have developed many of the world’s leading passenger rail applications, domestic designers and suppliers can use new U.S. rail installations to expand their application base.

Embedded system designers with expertise in defense, aerospace, industrial or automotive applications can transfer the harsh-environment, high-vibration aspects of those safety-critical market experiences into the railway sector. Conversely, U.S.-based designers needing to assemble components for safety-critical rail system designs can benefit from purpose-specific SBCs, modules and subsystems already rigorously proven in demanding European rail applications.

Here are a few representative examples of embedded computing opportunities in railway environments from the ground up.

MAINTENANCE CONTROL

Computer-aided tamping systems help to calculate and visualize track geometry as well as control the subsequent track-laying process itself. Allowable deviations of the track geometry are limited to a few millimeters in all three dimensions. The same systems can monitor track geometry during initial installation as well as subsequent periodic maintenance drives. Automatic ballasting and tamping operations call for extremely rugged electronic equipment to maintain precision despite the heavy shock and vibration experienced during track maintenance.

TILT CONTROL

Tilt-control technology uses sensor-controlled actuators to adjust the railcar body in relation to the “bogie” or wheel truck on which it rides, depending on the centrifugal forces encountered. This allows safer operation and greater passenger comfort in turns, with fewer compromises in high-speed performance. Efficient bogie control also leads to lower energy consumption.

AUTOMATED TRAIN PROTECTION

Positive train control (PTC) is a communication-based system that uses GPS capabilities for position assessment and radio frequency data links for communication with dispatch offices, grade crossings and railway workers along the right-of-way. It is designed to prevent train-to-train collisions, enforce speed restrictions and temporary slow orders, and provide protection for workers and their equipment operating under specific authorities.

Designers new to automated train protection can learn from European implementations of a radio system called Global System for Mobile Communications–Railway (GSM-R). GSM-R technology uses frequencies reserved specifically for rail applications to provide voice and data communication between tracks and trains. A train-based computer controls speed according to various characteristics of the rail equipment and operational conditions of the track.

PASSENGER INFORMATION SYSTEMS

Infotainment solutions keep passengers updated regarding route stops,
Mobile Resource Management
Quality In-Vehicle Computer and Tablet Solutions
About Advantech-DLoG

Advantech is a leading global manufacturer of industrial PCs and has established a great deal of experience and expertise in specialized industrial vehicle computing, such as that used in trucks and trailers.

DLoG GmbH is a global player in the field of industrial applications for in-vehicle computing solutions in extremely demanding environments. DLoG is renowned for its excellent German craftsmanship and design capabilities. The company, ranked third in the European market, is a leading provider of rugged industrial computers used in construction machinery, forklifts, mining engineering, and industrial manufacturing.

DLoG was acquired by Advantech in March 2010. Following the acquisition, Advantech began expanding its global industrial in-vehicle computing market under the new brand name Advantech-DLoG. Combining the experiences and leading market positions acquired by both companies, Advantech-DLoG aims to become the leading supplier of industrial vehicle computing products and services for select vertical markets worldwide, such as warehousing, heavy duty applications and fleet management.

Mobile Resource Management

Mobile Resource Management (MRM) is the process of optimizing, dispatching and tracking the use of assets and people that are involved in the movement of goods. The focus domains covers asset management, fleet management, and mobile workforce.

Asset Management

Fast, correct, real-time data capture and access are key issues in the asset management. Advantech-DLoG brings advanced computing to extreme environments, coping with dust, shock, vibration, humidity, impact, physical abuse, and extremely temperatures. From mechanical engineering to radio antenna design, from rugged to extreme, Advantech-DLoG ensures the security of your assets and helps you to manage them.

Fleet Tracking

Advantech-DLoG in-vehicle computing and fleet management solutions translate real-time data about vehicles, cargo, deliveries and workers into dynamic, understandable displays that help increase productivity and lower operating costs.

Mobile Workforce

Advantech-DLoG provides industrial-grade mobile computing devices with strong and reliable hardware design to survive in harsh environments; flexible selectable function modules to fit different systems; and light-weight design and accessories to reduce burden over the entire work day.

Certified Car Power Solution

Advantech-DLoG develops power management software to optimize your usage, and we insist that all systems pass vehicle related tests, such as SAE J1113/ISO 7637-2/E-mark to ensure customer equipment can operate well in severe environments.

Wide DC Input Range

Normally, for a 12V/24V vehicle power system, the DC voltage may go down to 6V/8V during peak loading (see Figure 1), and it may be subject to engine charging up to a maximum of 32–34 V. If there were no power protection, this dirty power input might cause a fleet management system malfunction; in fact this very thing happens easily in old trucks. Therefore, providing for a wide DC input voltage range avoids damage to the system.
Power Management
Efficient powernet energy management requires embedded software control. Software design must be integrated with hardware design from the beginning of power development to avoid complications during system implementation.

SAE J1113/ ISO 7637-2/ E-mark Certifications
The automotive environment is fraught with electrical hazards. These hazards, including electromagnetic interference, electrostatic discharges and other electrical disturbances, are generated by various vehicular sub-systems such as ignition, relay contacts, alternator, injectors, and accessories. These generated hazards can occur directly in the wiring harness in case of conducted hazards, or may affect electronic modules indirectly via induction. These hazards can impact the electronics in two ways—either on the data lines or on the power rail wires, depending on the environment. Therefore, in order to assure good power design, Advantech-DLoG products are always certified—our guarantee of design quality.

In-vehicle Wide Working Temperature Range
Advantech-DLoG products support operation under a wide range of working temperatures. TREK series devices were tested in accordance with SAEJ1455 4.1.3.1 standards over a 24 hr period; the results are shown below for reference:

Advantech uses industrial-grade components to ensure reliability and durability. During the early design stages, a rigid thermal simulation is performed and reviewed against actual test results. And depending on result outcomes, key components for durability are then put under strict wide range temperature testing as defined for industrial equipment (-40 to 85° C, see Figure 2b). The net result is that systems are able to operate without failure at ranges of -30 to 70° C (see Figure 2a).

Vibration and Shock Resistance
Advantech-DLoG responds to the problems associated with electronic systems operating in harsh vehicle environments by thorough research and design. Quality Assurance personnel physically test products in the environment in which they will be used. The development and testing that is conducted follow SAE J1455 4.9.4.2, and MIL-STD-810G 514.5, and EN60721-3-5 class SM3 standards.

The “EN60721-3-5 class SM3” standard certification means the product can withstand three times the shock and vibration of most military MIL-810G grade computing devices. Note: EN60721-3-5: Classification of environmental conditions - Part 3: Classification of groups of environmental parameters and their severities - Section 5: Ground vehicle installations.

<table>
<thead>
<tr>
<th>Test Vibration Curve</th>
<th>Test Shock Curve</th>
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<tbody>
<tr>
<td>EN 60721-3-5 Class SM3 Random Vibration Test (3.38Grms)</td>
<td>EN 60721-3-5 Class SM3 Shock Test – Level II (100G /6ms)</td>
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<tr>
<td>10~500Hz, 3.38Gms, 1hr/per axis</td>
<td>Test PSD: 10<del>200Hz: 3 m²/s³, 200</del>500Hz, 1 m²/s³</td>
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</table>

Figure 1 in ISO 7637-2 for 24-V vehicle power system

Figure 2 in ISO 7637-2 for 24-V vehicle power system
<table>
<thead>
<tr>
<th>Model Name</th>
<th>TREK-722</th>
<th>TREK-723</th>
<th>TREK-753</th>
<th>TREK-303RH</th>
<th>TREK-303DH</th>
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<tbody>
<tr>
<td>Processor</td>
<td>TI ARM Cortex-A8 AM3703 800 MHz</td>
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<td>OS</td>
<td>WinCE6.0 &amp; optional Android 2.3.4</td>
<td>WES 2009, WinCE6.0 and Ubuntu Linux 10.04</td>
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<td>Memory</td>
<td>On board 256MB Mobile LPDDR</td>
<td>One 200-pin SO DIMM socket, Supports up to 2 GB DDR2 400/533 memory module</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Size/Type</td>
<td>On board NAND type 2GB for boot loader, operating system &amp; customer apps</td>
<td>1 x external accessible SD slot,</td>
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<td>Display</td>
<td>5&quot; (16:9) TFT LCD</td>
<td>7&quot; (16:9) TFT LCD</td>
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<td>4-wire resistive type</td>
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<td>Brightness Control</td>
<td>Built-in light sensor for auto backlight adjustment</td>
<td>2 x hotkeys in front panel; built-in light sensor for auto backlight adjustment</td>
<td>Built-in light sensor for auto backlight adjustment</td>
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<tr>
<td>I/O Ports</td>
<td>2 x USB host, 2 x RS-232, 1 x CAN with J1939 protocol, 2 x DI/DO</td>
<td>3 x USB host, 2 x RS-232 with DC output, 1 x RS-485, 1 x CAN w/ J1939, 1 x J1708, 4 x isolated DI/DO</td>
<td>36-pin locking type connector (connect to TREK box, power/wake up button)</td>
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<tr>
<td>Audio</td>
<td>Built-in 2 watt speaker</td>
<td>Built-in 2 watt speaker</td>
<td>Built-in 2 watt speaker</td>
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<td>WWAN</td>
<td>GPRS : Cinterion TO631 quad-bands</td>
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<td>1 x 10/100/1000 Mbps</td>
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<td>Bluetooth</td>
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<td>-</td>
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<tr>
<td>Power</td>
<td>12V/24V car power design, DC-input 6V ~ 36V with ISO 7637-2, SAE J1113 &amp; E-mark</td>
<td>12V/24V car power design, DC-input 6V ~ 36V with ISO 7637-2, SAE J1113 &amp; E-mark; option to support 48V car power system</td>
<td>12 V ± 5% (Powered by TREK-5xx/6xx)</td>
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<td>Operating Temperature</td>
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<td>-30° C ~ 60° C</td>
<td>-30° C ~ 70° C</td>
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<td>Vibration/ Shock</td>
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<td>MIL-STD-810G, EN-60721-3-5 (M3)</td>
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<tr>
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<td>CE, FCC, UL/cUL, CB, CCC, E-mark, PTCRB, EN50155</td>
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<td>-</td>
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<tr>
<td>Dimensions (W x H x D)</td>
<td>165 x 115 x 43 mm (TREK-722)/ 213 x 145 x 43 mm (TREK-723)</td>
<td>256 x 161 x 56 mm</td>
<td>244 x 160 x 41 mm</td>
<td>212.75 x 141.85 x 35 mm</td>
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<tr>
<td>Weight</td>
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<td>2.2 kg</td>
<td>0.8 kg</td>
<td>0.76 kg</td>
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</tr>
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</table>
**Product Information**

### In-vehicle Box Computers

<table>
<thead>
<tr>
<th>Model Name</th>
<th>TREK-668</th>
<th>TREK-674</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Processor</strong></td>
<td>Intel Atom N2800 1.6 GHz</td>
<td>Intel Atom Baytrail-E, E3827 (Dual Core, 1.75GHz)</td>
</tr>
<tr>
<td><strong>OS</strong></td>
<td>WES7/Win7</td>
<td>WES7/Win7, WES8/Win8</td>
</tr>
<tr>
<td><strong>Memory</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Size</td>
<td>DDR3 up to 2GB</td>
<td>DDR3L up to 4GB</td>
</tr>
<tr>
<td><strong>Video</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CRT</td>
<td>1 x VGA output by DB-15 (supports different content with CRT port)</td>
<td>1 x DB15 (Resolution up to 2560 x 1600)</td>
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<tr>
<td>LVDS</td>
<td>1 x (supports different content with CRT port)</td>
<td>1 x (supports thought smart display port 840 x 480 or 1024 x 768)</td>
</tr>
<tr>
<td>Video-in</td>
<td>For surveillance: support up to 12 Video inputs, with 12V/2A power supply for camera</td>
<td>8-ch Video inputs: support H.264, MJPEG format; up to D1, 30fps per channel</td>
</tr>
<tr>
<td><strong>Audio</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mic-in, Line-in, SPK-out, &amp; audio input</td>
<td>Mic-in, Line-in, 1 Line-out for Speakers on TREK-36x</td>
</tr>
<tr>
<td><strong>Ethernet</strong></td>
<td>1 x Giga LAN 10/100/1000 Mbps Ethernet controller, supports POE IP camera; compliant EEE 802.3af and provides up to 15.4 watts power output</td>
<td>1 x Giga LAN, with locked-type RJ45 connector (&quot;Dual Giga LAN* is project-based)</td>
</tr>
<tr>
<td><strong>USB</strong></td>
<td>4 x USB host ports</td>
<td>1 x USB 3.0, 2 x USB 2.0</td>
</tr>
<tr>
<td><strong>Serial Ports</strong></td>
<td>2 x full function RS-232 with DC Output, 2 x RS-485</td>
<td>1 x Full RS232</td>
</tr>
<tr>
<td><strong>I/O Interface</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>GPS</strong></td>
<td>50-Channel ultra L8A-65s with AGPS as default (aux L8A-6R with AGPS &amp; dead reckoning feature (built-in GPS &amp; speed line) as option)</td>
<td>Build-in u-Blox L8A-65s module, support AGPS, (Dead Reckoning / Bonus) / Caliber /Bin/Duo is project-based.</td>
</tr>
<tr>
<td><strong>WWAN</strong></td>
<td>GPRS : Digitek MC55i &amp; MC55ii (with GPS) &amp; Standard CDMA - Sierra wireless MC5728V (Revision 1.4 &amp; 2.0) with AGPS &amp; dead-reckoning feature (built-in GPS &amp; speed line)</td>
<td>HVAC Wireless AirPrime MC8090 with AGPS (Dead Reckoning / Bonus) Caliber / Bin Duo is project-based.</td>
</tr>
<tr>
<td><strong>Bluetooth</strong></td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Storage</strong></td>
<td>1 x external-accessible port (for memory made only)</td>
<td>1 x external-accessible CFast slot (support system bootup)</td>
</tr>
<tr>
<td><strong>SATA</strong></td>
<td>2 x SSD (optional)</td>
<td>1 x external-accessible 2.5&quot; SSD tray with key-lock protection</td>
</tr>
<tr>
<td><strong>Operating Temperature</strong></td>
<td>-30°C – 60°C</td>
<td>-30°C – 70°C</td>
</tr>
<tr>
<td><strong>Certifications</strong></td>
<td>CE, FCC, UL/cUL, CCC, E-mark, PTCB, CNS1515</td>
<td>CE, FCC, CCC, UL/cUL, CB, E-mark, ISO 7637-2, SAE J1133</td>
</tr>
<tr>
<td><strong>Dimensions (W x H x D)</strong></td>
<td>346 x 97 x 196.2 mm</td>
<td>294 x 184 x 73 mm</td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td>5.7 kg (including 2 HDD)</td>
<td>3.6 kg (TBD)</td>
</tr>
</tbody>
</table>

### Industrial Tablet

<table>
<thead>
<tr>
<th>Model Name</th>
<th>PVS-770</th>
<th>MI-TM101</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Processor</strong></td>
<td>Intel Atom N2900/1.6GHz</td>
<td>Intel N2930/1.8GHz</td>
</tr>
<tr>
<td><strong>Memory</strong></td>
<td>5064 MB DDR3 up to 8GB</td>
<td>5064 MB DDR3</td>
</tr>
<tr>
<td><strong>Storage</strong></td>
<td>128GB SSD</td>
<td>32GB, 128GB, 256GB, 512GB, 1TB, 2TB, 4TB, 8TB, 12TB</td>
</tr>
<tr>
<td><strong>Display</strong></td>
<td>10.4&quot; XGA (1024 x 768) (Transflective) LCD</td>
<td>10.1&quot; WXGA (1280x800)</td>
</tr>
<tr>
<td><strong>Brightness (cd/m²)</strong></td>
<td>300 (Typical)</td>
<td>300 (Typical)</td>
</tr>
<tr>
<td><strong>Weights</strong></td>
<td>1 kg</td>
<td>1 kg</td>
</tr>
</tbody>
</table>

### Accessory

<table>
<thead>
<tr>
<th>Accessory</th>
<th>TREK-668</th>
<th>TREK-674</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power</td>
<td>Main battery: 351P 11.1V 1800 mAh</td>
<td>Main battery: 352P 11.1V 2865 mAh</td>
</tr>
<tr>
<td>Power High</td>
<td>AC Adapter: AC 100V~240V 50/60Hz, 19V/3.42A</td>
<td>AC Adapter: AC 100V~240V 50/60Hz, 19V/3.42A</td>
</tr>
<tr>
<td>Environmental Operating Temperature</td>
<td>-10°C to +55°C (charging activity will be active during 0°C to 40°C for battery safety)</td>
<td>-10°C to +55°C</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>-20°C to +70°C</td>
<td>-20°C to +70°C</td>
</tr>
<tr>
<td>IP Rating</td>
<td>IP54</td>
<td>IP54</td>
</tr>
<tr>
<td>Drop</td>
<td>4 ft drop onto plywood, MIL-STD-810G 516.5 Procedure</td>
<td>4 ft drop onto concrete</td>
</tr>
<tr>
<td>OS</td>
<td>Windows 7 Professional / Embedded</td>
<td>Windows Embedded 7 &amp; 8</td>
</tr>
</tbody>
</table>

**Website:** www.advantech.com • **Email:** ACGInfo@advantech.com
schedules, tips for changing trains, last-minute route changes or delays. They can also provide weather forecasts, news of the day and entertainment in the form of TV, movies or music. Content servers used to store data and programming connect to screens within the vehicle via wired LAN or WLAN. The servers connect to the outside world via various wireless standards, to receive up-to-date information even while traveling.

**OTHER COMMUNICATIONS FUNCTIONS**

Beyond safety-critical control and passenger entertainment features, vehicle-mounted computers can support other communications-based functions, such as surveillance of passenger compartments and doors in trains, subways and street-cars. Digital video recorders capture closed circuit television (CCTV) images to disk and store collected event data.

**ANSWERING EXTREME ENGINEERING CHALLENGES**

The new developments in American rail service offer both challenges and rewards for embedded systems designers qualified to address extremes of design and performance according to relevant standards, such as ANSI/ISA S84 or IEC61508.

Any computer system developed and manufactured according to railway standards must be robust and reliable, even if only for non-critical services such as heating or interior lighting. But the most extreme safety-critical tasks—such as locomotion, braking and train control—demand special design strategies such as hardware redundancy and complex software to deliver a higher safety integrity level (SIL).

For SIL4 operation in rail applications, a COTS single-board computer can provide a triple-redundant, 2-out-of-3 system, yet still be programmed like a single-CPU/memory system. Two identical SBCs connected in a cluster form a safe I/O concept. All processors run the same program in lockstep mode and perform the same tasks simultaneously, while a voter compares the output of all processors. Working memory is triple-redundant, while ECC-secured flash and local power supplies are dual-redundant. All critical functions are implemented as IP cores in an FPGA that also features triple-redundant structures. And for increased safety and availability, additional diagnostic mechanisms help to detect latent errors before they lead to a system error.

Since 1992, Barbara Schmitz has served as chief marketing officer of MEN Mikro Elektronik. Schmitz graduated from the University of Erlangen-Nürnberg. MEN Mikro Elektronik is an established manufacturer of failure-safe computer boards and systems for extreme environmental conditions in industrial, safety-critical and real-time embedded applications worldwide.

The Federal Railroad Administration (FRA) is encouraging the industry to implement Intelligent Railroad Systems—including new sensor, computer and digital communications technologies—as integrated solutions that will compound the benefits for train control, braking systems, grade crossing safety and defect detection.
MISRA C:2012: Ideal for Life-and-Death Applications

The newest version of MISRA lets developers of safety-critical applications—such as flight, high-speed rail, medical devices or nuclear power plants—take advantage of more C features while helping them mitigate risk.

By Chris Tapp and Mark Pitchford, LDRA

For C programmers working on safety-critical applications, following restrictions and guidelines to ensure safe-coding practices can be painful. Features of the language designed to make your work easier and more efficient, or to provide work-arounds for obstacles are often just the features that the guidelines disallow. However, the life and death risk of safety-critical applications whether for flight, high-speed rail, medical devices or nuclear power plants demand problem-free software. The risks prohibit taking chances.

Because of this, many industries choose to adhere to appropriate coding rules. Although the industry standards do not prescribe adoption of MISRA C, it has become the de facto programming standard for all safety-critical software. The newest version of MISRA C offers new hope for programmers by permitting more flexible use of the language while retaining the MISRA reputation as the safest C guideline available.

The automotive industry has undergone a significant transformation with the increased use of electronic systems. Defects in the software driving these systems directly affect vehicle safety. Standards such as ISO 26262 help the automotive industry comply with the specific needs of the electrical, electronic and programmable electronic (E/E/PE) systems of road vehicles. And adherence to appropriate coding rules is one of the key demands of ISO 26262.

ISO 26262 is a relative newcomer as far as safety standards are concerned, although it shares a common ancestry with standards used in other safety-critical sectors (Figure 1). While it provides a sound framework in which to develop functionally safe automotive applications, it stops short of dictating exactly how that should be done. Automotive developers often follow in-house templates, but with the increase in the amount of safety-critical electronics in today’s vehicles, combined with the increasing cost of litigation if software quality efforts cannot be proven, many of these developers are now looking at recognized outside guidelines.

The medical space is another industry where standards compliance lags behind other industries in proactively implementing certification. However, the consequences for defective medical applications can be considerable. Witness the recent recall of Baxter Healthcare’s infusion pumps in 2010¹. This cost the company in the neighborhood of US$400 to US$600 million².

Consequences like these have increased the call for application of best-practice and coding standards. And this has given rise to IEC 62304, the international standard for software lifecycle processes in medical device software, which has been adopted by both Europe and the United States. Although relatively new, IEC 62304 is based on IEC 61508, a generic standard for safety-related systems first published in 1998.

MISRA-checked code has fewer defects and it is more maintainable, readable, consistent and verifiable.

Consequently, hundreds of applications have used MISRA coding rules for IEC 61508 compliance and other related industry-specific standards for railway, nuclear, and process industries.

Given the world-class reputation MISRA has established in programming excellence, these newer industry standards are simply adopting MISRA as a proven way to obliterate errors. Obviously, if it has stood the test of time in industrial safety and avionics, then it can do so for them as well.
Rugged Boards & Solutions
We know PCIe/104. And we do it best.

At RTD, designing and manufacturing rugged, top-quality boards and system solutions is our passion. As a founder of the PC/104 Consortium back in 1992, we moved desktop computing to the embedded world.

Over the years, we’ve provided the leadership and support that brought the latest signaling and I/O technologies to the PC/104 form factor. Most recently, we’ve championed the latest specifications based on stackable PCI Express: PCIe/104 and PCI/104-Express.

With our focused vision, we have developed an entire suite of compatible boards and systems that serve the defense, aerospace, maritime, ground, industrial and research arenas. But don’t just think about boards and systems. Think solutions. That is what we provide: high-quality, cutting-edge, concept-to-deployment, rugged, embedded solutions.

Whether you need a single board, a stack of modules, or a fully enclosed system, RTD has a solution for you. Keep in mind that as an RTD customer, you’re not just working with a selection of proven, quality electronics; you’re benefiting from an entire team of dedicated engineers and manufacturing personnel driven by excellence and bolstered by a 28-year track record of success in the embedded industry.

If you need proven COTS-Plus solutions, give us a call. Or leverage RTD’s innovative product line to design your own embedded system that is reliable, flexible, expandable, and serviceable in the field for the long run. Contact us and let us show you what we do best.
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We know PCIe/104. And we do it best.
MISRA—a subset of the C language created in the 1990s by the Ford Motor Company and the Rover Group—has become a coding foundation for many safety-critical industries. MISRA C was originally released in 1998 (MISRA C:1998) to target C90, and it was superseded in 2004 (MISRA-C:2004) to include a host of extensions and improvements to the original. While MISRA C is actually a language subset, not a coding standard, it provides a sound basis for coding best practices. Over the years, MISRA C has gained widespread acceptance in safety-, life- and mission-critical applications and is widely referred to as the MISRA standard.

MISRA offers a straightforward way to ensure that a medical device meets the call of IEC 62304 to “consistently achieve the desired code characteristics.” Following the new rules helps programmers mitigate software-related risks for medical applications. Even a dispersed development team—such as a prime contractor with many subcontractors—that follows the MISRA guidelines can be confident that all of the code will be consistent across the project. Following the new guidelines, whether classified as rules or directives, helps programmers mitigate software-related risks for safety-critical applications. Ultimately, it allows them to spend more time coding and less time on compliance efforts.

WHAT HAS MISRA DONE FOR YOU LATELY?

In MISRA C:2012, guidelines have been made more precise so that the standard will not prevent reasonable uses or behaviours that have no undesirable consequences. This will be good news for developers who may have been frustrated in the past by rules that were more restrictive than was necessary.

The new MISRA C aims to make development as predictable as possible, across projects or pieces of code, without errors of interpretation. Repeatability and predictability are key drivers. Even a dispersed development team—such as a prime contractor with many subcontractors—that follows the MISRA guidelines can be confident that all of the code will be consistent across the project. Following the new guidelines, whether classified as rules or directives, helps programmers mitigate software-related risks for safety-critical applications. Ultimately, it allows them to spend more time coding and less time on compliance efforts.

The updated version also tells developers if a rule is “decidable”—those against which an analysis tool can always determine compliance or non-compliance—versus “undecidable,” where a person must make an assessment (generally due to pointer or data values affecting control flow) (Figure 3). Undecidable rules can result in false-positive or false-negative test results simply because the tool has inadequate information available to it during analysis. This improvement in rules definition significantly reduces manual code-review requirements, and lets developers know ahead of time if another method of testing should be used.

MISRA C:2012 OFFERS A REASONED APPROACH

Let’s look at some specific examples of programming approaches that are now...
Reasons For A New MISRA Version

Any updated coding practices or standards require developers to learn new guidelines and update their tools and programming methodologies. But this short-term inconvenience is outweighed by the advantages of updates that improve existing rules, extend support to the latest version of the language, and reduce development efforts overall. MISRA C:2012 was designed to:

• Extend the coding guidelines to embrace unsafe elements of C99 while retaining support for C90
• Support and enhance the improved definition of undefined or unspecified behavior in C99
• Correct issues found in the 2004 version
• Provide backwards compatibility as much as possible to make it unnecessary to modify code when moving from MISRA C:2004 to MISRA C:2012
• Ensure all guidelines include a detailed rationale and remove rules without strong rationale
• Increase the number of decidable rules to allow better tool enforcement and reduce the amount of manual checking, saving time and money
• Include guidance on the applicability of guidelines to automatically generated code

Freeing memory: aka, being too clever for your own good

In some instances, developers have freed memory that is automatically allocated to variables for use elsewhere. This is legitimate C syntax, but is dangerous. The new MISRA rule prevents developers from being too clever for their own good. In this case, the rule states that a block of memory shall only be freed if it was allocated by means of a standard library function.

```c
void fn ( void )
{ int32_t a;
  free (&a); /* Non-compliant - a does not point to allocated storage */ }
```

MISRA C:2012 defines guidelines as “Required,” “Advisory” or as a new “Mandatory” category, and this memory rule, for instance, is an example of a Mandatory rule that must never be broken (Figure 4). Required and Advisory guidelines can be broken with varying degrees of justification required, so that an “Advisory” rule might be at a programer’s discretion, while “Required” might require the approval of a manager.

THE RATIONALE BEHIND THE GUIDELINES

The previous versions of MISRA dictated what should be done, offering no rationale to explain the rule’s intention. This new version enhances the concept of “rationale,” providing descriptions that explain why each guideline is a good idea.

For instance, it is now a requirement that typedefs that indicate size and signedness should be used in place of the basic numerical types. For example, on a 32-bit C90 implementation the following definitions might be suitable:

```c
typedef signed char int8_t;
typedef signed short int16_t;
typedef signed int int32_t;
typedef signed long int64_t;
```

From the perspective of portability, the rationale debunks the possible false perception that adherence to this guideline guarantees portability because the size of the int type may determine whether or not an expression is subject to integral promotion. For example, an expression with type int16_t will not be promoted if int is implemented using 16 bits but will be promoted if int is implemented using 32 bits. In other words, the rationale helps guide the developer around a common pitfall.

NOT ALL GOTO STATEMENTS ARE EVIL!

All too often, goto statements are used to patch up fuzzy thinking or an ill-defined algorithm. Indeed, there are situations where the use of the goto statement is justified. For example, if there is an emer-
Figure 4: MISRA C:2012 introduces a “Mandatory” category for rules which must never be broken, to complement the existing “Required” and “Advisory” categories. As illustrated, the TBvision automated compliance checking tool can summarise information on any identified violations.

Figuring out what to do in an emergency situation in a guidance algorithm, it is better to take a direct route via a goto. There's not time to set a flag and check its status later in the loop. Because of this, the “goto statement should not be used” rule is now advisory rather than required, and an additional two rules narrow down the circumstances under which it is acceptable:

- The goto statement shall jump to a label declared later in the same function.
- Any label referenced by a goto statement shall be declared in the same block, or in any block enclosing the goto statement.

AUTO-GENERATED CODE NEEDS CHECKING, TOO

Auto-generated code, often used for automotive applications, is still written by a software developer, whether as templates or hand-coded “S” models. Ensuring that the generated code complies with a language subset (such as MISRA AC) confirms that there are no errors in that manual implementation that affect the quality of the auto-generated source code. The auto-generated rule set differs from that in hand-written C for a number of reasons. For example, auto-generated code can use variable names that are indistinguishable to human eyes but are still sufficiently unique for their purpose.

There are also occasions when auto-generated code is required to do the opposite of handwritten code. For instance, MISRA C rules dictate that a default statement should always be written into a case statement. The MISRA AC equivalent insists on the opposite because an auto-code generator cannot decide what the default action should be; the necessary addition to implement the default has to be added manually. The MISRA language subsets offer a path for any developer to take full advantage of their chosen language without limiting functionality.

MISRA C:2012 AND BEYOND

Although MISRA C:2012 provides an ideal basis for a language subset for any safety-critical application, ISO 26262 (automotive) and IEC 62304 (medical) do not dictate exactly what coding rules should be applied. With the right tools to help, development teams gain the flexibility to fine-tune the rule set to the requirements of a particular project by extending it with additional in-house rules or, with appropriate justification, by disabling selected MISRA rules (Figure 5). For example, Lockheed-Martin took this approach for the Joint Strike Fighter when they developed the JSF++ AV rules set based on the MISRA C++:2008 standard.

MISRA HELPS MEET CODING BEST PRACTICES

MISRA, in all its flavors, was developed to help software development teams create software applications of the highest quality. MISRA-checked code has fewer defects and it is more maintainable, readable, consistent and verifiable. Essentially, MISRA is about applying best practices in coding, a principle underlined by the references to appropriate coding rules in ED-12C, DO-178C, IEC 62304, ISO 26262, etc. Understanding and meeting the requirements of MISRA C:2012 can help you meet high software-quality assurance requirements while allowing you to make better decisions about features of the programming language.

Test tools that support MISRA compliance should allow you to easily choose between versions of the standard (C, C++, Java) and appropriate subset (MISRA C:2004 for legacy and MISRA C:2012 for new projects), and should allow you to choose full compliance or a user-defined subset of rules that meet in-house templates or requirements.

1 http://www.fda.gov/NewsEvents/Newsroom/PressAnnouncements
2 http://www.baxter.com/press_room/press_releases/2010/05_03_10_colleague.html

Chris Tapp is a field applications engineer at LDRA with more than 20 years’ experience of embedded software development. He has been involved with MISRA since 2001 and is currently chairman of the MISRA C++ working group and an active member of the MISRA C working group. He has been with LDRA since 2007, where he specialises in programming standards.

Mark Pitchford has over 25 years’ experience in software development for engineering applications. He has worked on many significant industrial and commercial projects in development and management, both in the UK and internationally including extended periods in Canada and Australia. Since 2001, he has specialised in software test, and works throughout Europe and beyond as a field applications engineer with LDRA.
Smart Antennas Drive Evolution in M2M and Automotive Applications

Smart antennas provide the capability to co-locate the antenna and black-box functionality for better performance and lower cost.

By Jason Furr and Vidhya Dharmarajan, Laird Technologies

The power of machine-to-machine (M2M) technology is driving towards a more connected world. All kinds of machines are getting connected to the Internet of Things to deliver the promise of enhanced productivity and to bolster the performance of businesses.

The evolving realms of technology are revolutionizing many industries. The automotive industry is trending towards intelligent cars that are fully connected in order to achieve vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication for improved safety. Fleet management companies are utilizing M2M systems to monitor operational performance and service efficiency using real-time fleet tracking. Smart technology is enabling improved supply chain systems in industries such as vending and service.

Reliable non-stop connectivity requires that these systems support a wide array of wireless capability. This means machines are getting packed with Bluetooth, Bluetooth Low Energy (BLE) and Wi-Fi for personal or local network connection; Cellular protocols such as 2G, 3G, 4G and LTE for wide-area network connection; and global navigation satellite systems (GNSS) such as GPS, Galileo, Glonass and Beidou to support location-based services. This demand for added capability pushes toward higher system-level sophistication which can create challenges.

Even though this architecture is used on many M2M systems, it poses several potential system concerns. First, RF cables inherently have loss; the longer the cable, the more antenna gain lost between the black box and the antenna negatively affecting system performance. Second, there are two cost implications. Running multiple RF cables increases the total cost of the system, especially if the distance between the black box and the antenna is large. Additionally, as more technology gets added to the M2M system, more cables need to be run, which also adds cost and complexity. Finally, with more cables and more connectors within the system there are increased installation costs and higher risk of intermittent connection failures. For example, in heavy equipment and automobiles that are prone to vibration, there could be higher instances of connector or cable damage resulting in loss of data.

One way to reduce system cost and improve efficiency in embedded M2M applications is to re-think the architecture of an embedded M2M system. Instead of depending on the black box to perform all of the critical tasks of the system, a system designer could pull the wireless portion of the design in to the antenna. This concept can be referred to as a smart antenna design.

Smart antennas provide an option to co-locate the antenna and some of the black box device functionality (mainly radios) into the antenna package. A single digital cable can then be run from the smart antenna to the depopulated black box. See Figure 2 for an example of how a smart antenna could be architected to work in a vehicle environment.

The embedded M2M system then becomes more efficient as the loss of data between the antenna and the black box is minimized with a digital cable versus antennas for the M2M system are in a different physical location than the black box and are connected to the black box via RF cables (as seen in Figure 1).

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The embedded M2M system then becomes more efficient as the loss of data between the antenna and the black box is minimized with a digital cable versus antennas for the M2M system are in a different physical location than the black box and are connected to the black box via RF cables (as seen in Figure 1).

Figure 1: Vending machine in a traditional M2M system
multiple coaxial cables. Digital signals can utilize error-correction software and are more resistant to electromagnetic noise and signal attenuation than analog signals. Additionally, cellular systems are evolving quickly and other wireless standards continue to get updated. Customers not only want to upgrade their systems from 2G to 3G and 4G but also want to add the most cutting-edge wireless functionality (i.e., BLE and Wi-Fi Direct). When the technology evolves, it drives hardware and software changes. These hardware and software changes then need to be re-validated and re-certified. By moving the wireless functionality into the antenna, the core black box no longer needs to evolve as quickly as the wireless market pushes. The smart antenna can truly act as the data pipe and the black box can focus on its key functionality.

**FINDING THE RIGHT FIT**

While a number of market players provide smart antenna solutions, not all of them are successfully able to address all of the challenges. Getting the design right is the first step.

Because the smart antenna packages additional components into the antenna, the size of the smart antenna may be larger than a regular antenna. Space and styling constraints on certain equipment will not allow larger smart antenna packages than typical antenna sizes. For instance, the styling of a vehicle is very important to vehicle OEMs. It is critical that the smart antenna is created with the customer’s or system integrator’s guidelines in mind.

Depending upon where the smart antenna is located on the subject equipment, there could be more stringent environmental challenges. Electronics that were once hidden inside of the equipment are now located outside of the equipment in the antenna package. This may create additional challenges with temperature, humidity, water ingress or a variety of other environmental factors.

Moving the radios from the black box into the antenna could pose firmware challenges. Typically the black box has been seen as the brain of the system with the antenna being the afterthought. When moving some of the electronics away from the black box to the antenna, it is critical to understand how information will be passed from the smart antenna to the black box. No longer is there just an RF signal coming from the antenna. Depending on the complexity of the smart antenna design, there could be RF data, location data and machine bus information passing over a digital line. In this case, there will be some firmware required within the smart antenna. If these issues are not addressed correctly during the system design phase, persuading system integrators to adopt smart antenna architecture will be a challenge.

Although challenges exist, the adoption of smart antenna technology in to the embedded M2M system space could lead to more efficient systems for companies looking to maximize performance while controlling initial capital expense and long term system evolution costs.

*Jason Furr is global sales manager for Laird, where he focuses on generating new business in the growing telematics & M2M markets. Jason holds a bachelor's degree in business from The University of Michigan-Dearborn and an MBA from Michigan State University.*

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- Also available with conduction cooling in MEN CCA frame

TECHNICAL SPECS

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**VME bus Variant:** VME, VME64X, VXS, VPX, OpenVPX, cPCI

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**TECHNICAL SPECS**

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- Avionics Isolation Tray
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**AVAILABILITY**

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VME bus Variant: VME, VME64X, VXS, VPX, OpenVPX, cPCI

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FEATURES & BENEFITS

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◆ Modular power supply
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TECHNICAL SPECS

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  or 5.25” h x 6.5” w x 8.5” d
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AVAILABILITY

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APPLICATION AREAS

Harsh transportation and industrial environments requiring small form factors and where extreme temperatures, air particulates, liquids and vibration prevent the use of standard commercial computers.

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- Three internal PCI Express Mini Card slot and one SIM slot
- Lockable I/O interface and M12 LAN, audio, power and USB connector
- Comply to fire protection of railway vehicles Europe standard PrCEN TS 45545-2

TECHNICAL SPECS

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APPLICATION AREAS

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Energy Harvesting Trends

Despite the growing number of benefits that energy harvesting presents, there are challenges engineers face in integrating harvesting platforms into the design process.

By Christian DeFeo, Newark element14

Energy harvesting is altering the way engineers think about power management and smart energy. Today’s harvesting trends suggest more institutions are taking advantage of it. Despite this, and the growing number of benefits that energy harvesting presents, there are challenges engineers face in integrating harvesting platforms into the design process, from both the manufacturer and developer perspective. As both a concept and practical application, energy harvesting has existed for quite some time. It is only now, however, that we’re discovering its extended potential.

PRESENT USE CASES
We are already seeing unique and interesting applications of energy harvesting solutions across industries. Phillips, for example, is working on a television remote control powered by motion. European universities are building entire academic programs dedicated to studying the use of nanomaterials for energy, as well as the motion of bridges to harvest energy. Even automotive manufacturers have referred to the “efficient dynamics” of newer cars, which harvest energy from the driver’s braking motions. All are examples of how the benefits of energy harvesting are encouraging institutions and industries to reevaluate their existing practices.

OPERATING BENEFITS
Energy harvesting presents several financial, environmental and design benefits for engineers and users alike. The most inherent of these is the replacement of traditional batteries. Returning to the example of television remotes, the costs associated with creating, shipping, purchasing and disposing of the batteries found in these devices offer little return value when considering the rate at which they are drained. Energy harvesting dispenses with the need for continuous power sources among lower power devices. In addition, energy harvesting offers a safer alternative to the various chemicals emitted into the atmosphere by traditional battery packs.

From a sustainability perspective, energy harvesting is one in a range of solutions which help us live greener lives. We can, for example, reduce our consumption of batteries by harvesting energy. We can also power devices in a cleaner and more efficient way. It is important, however, to bear in mind that as with many renewable sources of energy—solar, wind, etc.—energy harvesting operates under similar constraints. These power sources are not continual; they have peak times and times when they generate little to no power at all. Engineers must apply this logic across the board when using green technologies, and energy harvesting can substantially aid in the design process.

DESIGN CHALLENGES
Despite these benefits and more, energy harvesting faces several roadblocks to mass design integration. Energy harvesting is also known as “energy scavenging,” and as the term implies, it attempts to latch onto energy “scraps.” It is therefore not ideal for applications which will require a great deal of continuous power.

For engineers, they must re-think their understanding of energy: how do you take
However the power conditions may vary, design engineers experimenting with energy harvesting are still guessing which conditions their solutions will be used in, and those guesses won’t always be right.

To use an example, in our recent Energy Harvesting challenge, an engineer from Poland decided to make a carbon monoxide alarm that didn’t require battery or mains power. His first approach was to check how much energy he could derive using the Peltier module in the "Energy Harvesting Solution to Go" kit provided to him. He quickly realized that the energy wouldn’t be sufficient to power a conventional alarm.

This approach had the virtue of assessing what his energy budget was, and then building the application around it; however, it could be argued that he should have looked at how he could create such an alarm that used as little energy as possible first, then decided how to power it. In the first case, power sources determined the functionality; but perhaps functionality should be used to determine which form of energy harvesting is used, if not multiple sources of energy harvesting at once.

However the power conditions may vary, design engineers experimenting with energy harvesting are still guessing which conditions their solutions will be used in, and those guesses won’t always be right.

EMERGING SOLUTIONS AND TECHNOLOGIES

Solutions to energy harvesting design flaws will most likely arise from utilizing multiple sources of energy harvesting in one solution or product. Engineers may also take the approach of minimization: taking the functionality of a system and curbing its power system to the lowest level possible. This can be done by selecting the right low-energy chips, sensors and microcontrollers, and matching them with the correct energy harvesting power supply (such as the Piezoelectric and Peltier harvester modules). This isn’t easy—engineers will have to be able to store and manage energy when it is not available.

In the case of the aforementioned example, it was necessary to use a Figaro TGS 5042 sensor for our engineer’s carbon monoxide detector. This is an electrochemical sensor which doesn’t require power to operate. In terms of microcontrollers, the Silicon Labs EFM32 series have very low power consumption and are adapted for practical applications of this nature.

The key determinant in choosing among these various development approaches is environment. If you are in a scenario in which there are limited sources from which to derive power, i.e., somewhere that has thermal energy but no light or other forms of energy, then the power is going to determine the functionality you can have. If, on the other hand, you have access to multiple sources of energy, then perhaps the functionality can determine what power sources you tap into, and how much redundancy you put into your solutions.

Manufacturers can also play a part in easing the transition to energy harvesting designs. It is important to present the opportunity for engineers to get their hands on harvesting platforms if they wish to move beyond traditional power solutions. Capacitive manufacturers and battery manufacturers can also develop and offer batteries that already store energy efficiently, so that engineers are free to focus on other aspects of the design process. Again, this isn’t an easy task. If harvesting offers a viable energy alternative, and early applications suggest that it can, then it should be treated as one.

As the power requirements for applications continue to drop and, with the help of engineers, harvesting gathers increasing amounts of energy, we will all begin to see more practical uses of energy harvesting solutions arise.

Christian DeFeo is the e-supplier manager at Newark element14, a global electronics distributor and online community of 200,000 design engineers and tech enthusiasts. Recently, he oversaw an energy harvesting challenge at the element14 Community, in which engineers around the world developed power solutions for everyday devices.
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<tr>
<th>Model</th>
<th>Flash Memory</th>
<th>RAM</th>
<th>Package</th>
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These powerful microcontrollers provide a highly flexible and cost-effective solution to many embedded control applications, including:

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Four broad trends are changing operating conditions on electric-power distribution grids, and thus increasing stress on distribution infrastructure:

1. Energy-use preferences have been shifting toward electric power, resulting in electricity-use growth rates which are twice that of other energy sources.

2. Aging distribution equipment is now on average older than its manufacturers’ recommended operating lifetimes.

3. Increasing use of electronic loads reduces load power factors and decreases grid utilization efficiency.

4. Distribution grids are no longer static one-way power-delivery systems, but are now dynamic two-way links that also connect distributed generation resources to loads.

To accommodate changing use models and improve reliability, smart powerline monitors are necessary for utilities to track dynamic operating conditions on distribution grids. Let’s take a closer look.

CHALLENGES FOR THE GRID

Structurally, distribution grids have changed little over the past century. They developed to service comparatively modest, linear loads over moderate distances. Until a few decades ago, that model was a realistic characterization of distribution grids’ operating conditions. For the last several decades, however, electric power use has been changing. According to International Energy Agency (IEA) estimates, worldwide electricity demand rose from 5.1PWh to 17.9PWh (1015 Wh) between 1973 and 2010.¹ Although electric energy use more than tripled over 37 years, it represents only a 3.44% compound annual growth rate (CAGR). It is also more than double the CAGR of overall energy use, 1.69%, and of global population, 1.54%.²

During the same time, most monitoring technology deployments happened at generation and transmission facilities, with monitoring on the distribution grid limited to the head end at the substation. Historical use models allowed utilities to assume correctly that measurements at substations reflected operating conditions throughout the distribution grid. This assumption, however, is actually less valid because actual grid use has become more complex.

Upgrading the distribution infrastructure is expensive. According to a study commissioned by the Edison Electric Institute (EEI), the cost for newly constructed overhead distribution lines ranges from $86,700 to $1,000,000 (U.S. dollars) per mile, depending on the locale and population density.³ Costs for newly constructed underground distribution lines are more than three times those for overhead wires. Utilities are, therefore, eager to squeeze as much use from existing distribution grids as they can.

In addition to the three-fold increase of electric power use in absolute terms, the nature of power loads has changed over the same period in ways that affect grid capacity. Electric power generation and use are measured and billed in energy terms—the kWh. Utilities assess their distribution capacity, however, in terms of current.

Customers pay for real power—the instantaneous product of the voltage and current waveforms. Nonresistive loads present current waveforms that are not strictly in phase with the voltage waveform. In such cases, one can separate the current waveform into the real or in-phase component and the reactive or

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ZMOTION Intrusion Detection Block Diagram

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• Access control
• Customer sensing
• HVAC control
• Occupancy sensing
• Vending applications
• Automatic displays
• Proximity
• Power management

ZMOTION Development Kits

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<th>Description</th>
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<tr>
<td>ZMOTIONL100ZCOG</td>
<td>ZMOTION Detection and Control Development Kit</td>
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<tr>
<td>ZMOTIONL200ZCOG</td>
<td>ZMOTION 20-pin Detection and Control Development Kit</td>
</tr>
<tr>
<td>ZMOTIONS200ZCOG</td>
<td>ZMOTION Intrusion Detection Development Kit</td>
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Zilog offers a wide selection of lens and pyroelectric sensor bundled options to fit your application needs.

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The load extracts useful work from the real component of the current waveform, but the utility must provide the total current.

Power factor is a measure of real power, as a fraction of the sum of real and reactive power. Even a power factor as high as 0.9 accounts for up to 11% excess grid utilization over and above that for which the power provider can charge residential and most commercial customers (Figure 1). Although electronics manufacturers have been improving their products' power-factor performance, a large amount of legacy equipment is still in service with power factors as poor as 0.55, corresponding to 82% excess grid utilization (Table 1).

Much of the energy-use growth during the last several decades has been due to the penetration of electronic (as distinct from electric) devices, which present nonlinear loads to the grid. Nonlinear loads generate current-waveform harmonics, which also degrade power factor and drive up excess grid utilization. Various agencies and standards organizations set limits on the harmonic content of current waveforms, typically counting the first 40 to 50 harmonics corresponding to 2kHz to 3kHz measurement bandwidths depending on the controlling norm and locale.

Among the various user sectors, transportation has historically represented a small fraction of the total load on distribution grids (Figure 2). In percentage terms, transportation represents a smaller fraction of total global electric-energy use, but in absolute terms, the sector has more than doubled (Table 2).

In the U.S., the transportation sector's electric power use is set to grow faster than the historic organic rate due, in part, to a 2011 White House initiative with the goal of one million cumulative electric passenger vehicles (EVs) by 2015. Meanwhile, sales of hybrid-electric vehicles (HEVs) have grown to almost 3% of the annual 12-million vehicle U.S. market, and interest is growing in the plug-in versions of these vehicles.

EV and HEV adoption, however, has not homogeneously distributed across the entire county. Rather, sales have tended to cluster in 24 metropolitan areas so their effect on grid power demand will be greater in some geographies early in their adoption. One motivator for vehicle owners to switch to EVs or plug-in HEVs is the cost disparity between regular gasoline and the so-called eGallon—the cost of the electric-energy equivalent to a gallon of regular gasoline: The U.S. average price for a gallon of regular gasoline in August 2013 was $3.56 compared to $1.22 for an eGallon.

Finally, distributed generation and especially small-to medium-scale renewables are changing the distribution grid from a static, one-way power-delivery structure to a more complex and dynamic two-way system. In particular, customer-based photovoltaic and small-scale wind generation pushes power back onto the distribution grid when their power generation exceeds the customer’s immediate use and, if present, local storage capacity. Moderate-sized customer-owned photovoltaic sites, such as those appearing on the rooftops of office buildings and parking structures, can generate over 500kW and supply more than 250MWh annually. During low use periods, such as weekends, these facilities can push excess energy back onto the distribution grid.

With the distribution grid’s historic operating model, utilities have struggled to detect and respond to a variety of grid conditions, such as voltages at the grid edge from distributed generators.
THE HIGH COST OF FAILURE

The annual economic consequences of electric power reliability events (i.e., power failures) to U.S. power utility customers is about $79 billion according to the Lawrence Berkeley National Laboratory base-case estimate.¹⁰ Of this amount, about two-thirds is attributable to momentary service interruptions—those lasting less than five minutes. The duration for the remainder can extend from minutes to days. Loss figures do not include investments in power-failure mitigation equipment such as customer-owned backup generation, batteries or power-conditioning equipment to moderate power-quality events.

In addition to their own financial motivations, electric power utilities are under pressure from customers, industry organizations and regulatory agencies to minimize reliability events. Powerline monitors throughout the distribution grid can operate in concert with automated switchgear to quickly identify anomalous operating conditions, route around affected areas and expedite problem resolution.¹¹

Beyond asset management, monitoring valuable infrastructure components such as branch reclosers and secondary transformers is integral to fast-acting protection methods. Monitoring can also provide valuable data from the distribution grid’s edge. Deployment of powerline monitoring at the secondary transformer level is in its early stages, but is projected to exceed the traditional power-transformer market by 2015 (Figure 3).¹² This development is possible, in part, due to the availability of analog and mixed-signal IC components that greatly simplify the task.

SMART MONITORING

Powerline monitors located in the distribution grid are topologically similar to those at the substation and elsewhere in the electric power delivery system. Voltage transformers provide scaled representations of the voltage on each of the three power phases and on the neutral. Similarly, current transformers provide a voltage representation of the current passing through each of the three power phases and neutral. The monitor’s analog front-end (AFE) electronics can buffer the eight resulting signals and filter them to ensure that out-of-band (OOB) energy does not alias down to the baseband during the digitization process (Figure 4).

In common wye-connected distribution systems, the utility drives the three phases with 120° offset between pairs; voltages are measured with reference to a fourth neutral lead. Under balanced load conditions, 100% of the current flows through the phase connections. Current flowing through the neutral signifies an imbalance. Such an imbalance could indicate, for example, an emerging defect in a secondary transformer’s insulation system, thereby providing the utility with advanced warning and allowing them to replace the transformer on a schedule. Such edge information-gathering saves both the utility the cost of an emergency response and saves the customer the cost and inconvenience of an unanticipated field failure.

Calculating the power over one line cycle requires accurate and simultaneous measurement of both the voltage and current signals for each phase and the neutral. For each lead, the monitor must compute:

$$P_R = \int_{\theta=0}^{2\pi} v(\theta)i(\theta) \, d\theta,$$

Where $v(\theta)$ is the instantaneous voltage at cycle phase $\theta$, and $i(\theta)$ is the instantaneous current. The monitor can compute reactive power by multiplying the RMS
The European Union’s IEC 62053 standard for Class 0.2 equipment typifies requirements for power monitors. It calls for measurement error ≤ 0.2% of the nominal voltage and current. Power-factor measurement requires phase matching voltage and current samples to ≤ 0.1%.

Such measurement specifications require that the eight digitizers required for a three-phase line closely match one another and that their sampling times are tightly controlled. Analog and mixed-signal IC makers such as Maxim Integrated provide 4-channel analog-to-digital converters (ADCs) well suited to these measurements. The ADCs’ differential inputs and control features allow groupings of up to 32 channels of simultaneous sampling. Integrated 8-channel ADCs are also available for monitoring applications that can use single-ended inputs.

Data from a line’s eight voltage and current samples can feed a microcontroller or digital signal processor (DSP) to provide accurate power calculations and assessment of power factor. Systems can use the power factor data to control local capacitor banks and thereby improve overall grid utilization. Protection devices can use the power data for fast-acting automated breakers. Such systems can not only use the data to quickly open a breaker in the event of a sufficiently large line anomaly, but can also use the same data stream to close the breaker, minimizing the duration of the downstream power interruption.

REFERENCES:
4. Data for Table 1 were generated from direct measurements. Data source is JAS Technical Media ©2013.

David Andeen is the reference design manager at Maxim Integrated. He joined Maxim in 2005 in the sales department and assumed responsibility for the energy segment from 2011 through 2013. He holds a Ph.D. in materials science from the University of California, Santa Barbara.
Data Concentrators Are Key to Engineering a Smarter Grid

To design cost-efficient and future-proof concentrators, developers need to carefully consider WAN and NAN options, hardware platform scalability, software availability and networking/data security design.

By James Hao, Texas Instruments (TI)

According to a recent Annual Energy Outlook, worldwide energy consumption will increase 50 percent by 2035, and electricity alone will increase by 30 percent during the same time. Global demand for electrical power has outstripped supply and there’s no end to the situation in sight. Unfortunately, only generating more power is not a viable solution. A more feasible way for both the short and long term is to be more efficient with the electrical power that is already being generated and distributed over the grid.

A step in this direction would be to make the grid itself more intelligent so that power utilities, governmental regulators, power distribution companies and consumers could better monitor, analyze and control energy generation, distribution and usage. Along with smart meters deployed worldwide in the last ten years, data concentrators play a key role in enabling intelligent power consumption with more robust end-to-end communications.

CHALLENGES FACING THE SMART GRID

Data concentrators serve as the interface between the utility-controlled smart grid distribution network and end users, managing the data exchange between the utility and multiple smart meters in a particular geographical area. In both advanced metering infrastructure (AMI) and automated meter reading (AMR) systems, data concentrators—also called data aggregators—provide the core functionality required to measure, analyze and collect energy usage. They then communicate that data to a central database for billing, troubleshooting and analyzing.

Before we jump into the details about data concentrators, let’s take a look at the current grid challenges that concentrators need to address:

- First, a variety of communication standards and protocols exist between meters and utility servers. On one side, smart meters could be configured with a neighbor-area network (NAN) communications, featuring narrow bandwidth and lower power consumption, based on regional or country-wide policy, such as RS485, narrow band power line communication (PLC), broad band PLC, low power RF, etc. On the other side, utilities may have an existing wide-area network (WAN) communication, featuring higher bandwidth and higher data speed, to collect data such as GSM/GPRS (migrating to 3G/4G network), Ethernet, optical cable, even proprietary radio. The concentrator should have enough communication processing capability and flexible/configurable interfaces to deal with those protocols.

- Cyber security and privacy protection is a major concern. With the adoption of cloud-based smart grid solutions, increasing cyber threats are forcing stronger security measures on all levels of smart grid equipment. Research suggests the global smart grid cybersecurity market will grow at a CAGR of almost 30 percent over the period 2012-2016. Also, information from private residential dwellings needs to be protected, and not accessible by non-authorized parties. Specifically, utilities are requiring more and more security features on data concentrators, including device security, content encryption and anti-hacking.

- Real-time monitoring is needed to diagnose the status of a regional grid. Along with modern grid network migration, utilities need to access the status of the grid network, not only the residential low-voltage power grid, but also renewable and distributed energy networks, such as from solar inverters, solar panels, industrial lighting networks, etc. Metrology and power analytics will be required on data concentrators to monitor power-line performance and efficiency, so utilities can take immediate actions to reduce outage or fix local power line issues.

- Finally, support is needed for a number of applications, software and upgrades. To enable advanced applications such as demand response, metering data management, billing information statistics, inventory management, web browsing, networking protocol conversion, etc., utilities

Data concentrators serve as the interface between the utility-controlled smart grid distribution network and end users, managing the data exchange between the utility and multiple smart meters in a particular geographical area.
must have advanced operating systems and powerful processors on the data concentrator.

MAIN FUNCTIONS OF A DATA CONCENTRATOR

Data concentrators push intelligence to the edge of the grid by integrating, organizing and aggregating information from e-meters or other end equipment on the grid. Typically located at the transformer or a secondary substation level, data concentrators need to have the following basic functions (Figure 1):

- Provide reliable communication with meters and head ends
- Secure consumers’ data and information
- Monitor regional grid status
- Support various data management applications

TECHNOLOGIES TO CONSIDER WHEN DESIGNING DATA CONCENTRATORS

Typically, data concentrator systems use sophisticated designs based on microcontrollers (MCU) or microprocessors (MPU) and rely on multiple wireless or wired communication in the last mile. There are many considerations when starting to develop a concentrator system, including how system flexibility will comply with regional or global communication regulations, how system scalability will support from 10s of service node to more than a thousand service nodes with a reasonable cost structure, key security features, and how to support advanced applications. A superset of a smart data concentrator system is shown in Figure 2.

NAN COMMUNICATION OPTIONS

Power line communication (PLC) has been used for many decades and gained worldwide interest with its ability to modulate communication signals over existing power lines and enabling devices to be networked without introducing any new wires or cables. This capability is extremely attractive across a diverse range of applications, including utility metering, home area networks, lighting and solar, which can leverage greater intelligence and efficiency through networking.

A variety of new services and applications now require greater reliability and data rates than PLC techniques from the past. Several factors impact PLC performance, including impulsive and narrowband noise, time-varying line impedance and frequency-selective channels. Table 1 and Figure 3 present three-phase PLC data concentrator PHY test criteria and performance results with special care to cope with those factors.

PRIME, G3 and IEEE P1901.2 are the three PLC standards most discussed in the market recently, all of them based on orthogonal frequency division multiplexing (OFDM) modulation and channel coding techniques to efficiently utilize the CENELEC band (regulated in Europe) to achieve high resiliency to interference and attenuation, and data speeds up to 40kbps. If using the full FCC band (3kHz-490kHz), a higher data rate (40Kbps-1Mbps) can be reached. On the PHY layer, robust modes are defined and enable communication across the medium voltage (MV) to low voltage (LV) transformers. As a result, the latest PLC can achieve reliable communications up to 10 km away while crossing between medium voltage transformers. The standards also enable communications over the low voltage and medium voltage (LV/MV) transformer crossing for a total distance of up to 4-5 km, depending on the channel condition. 3 4 5

Figure 1: The main functions required of modern data concentrators

Figure 2: A diagram of a typical data concentrator system, based on TI’s Smart Data Concentrator reference design.
On the MAC layer, PRIME, G3 and IEEE P1901.2 support IPv4/IPv6 networks in an efficient manner so no additional router is needed to run in IP network.

To achieve the best bill of materials (BOM), a designer needs to consider and integrate analog front end (AFE) to support the full FCC band and a programmable PLC modem to support multiple PLC standards through a software upgrade method. At the network level, a developer also must consider the number of nodes connected to the concentrator, the number of levels from the “leaf” node to the “root” node, the reliability of the switch node, locations and length of the low voltage lines in order to run a reliable automated meter reading and control application.

Aside from PLC, low power RF technology is also widely used at certain regions, as well as RS485 communication used to support legacy meters deployed in those markets. Those require MCUs or MPUs with enough serial interfaces (for example, up to 8 UARTs).

### CONSIDERING WAN COMMUNICATION

10/100/1000M Ethernet and optical cable have been widely used in grid infrastructure as WAN options, but those may be not accessible everywhere, nor the best options from a CAPEX/OPEX perspective. Wireless access technology is another choice. Currently, GSM/GPRS technology has been adopted (up to 52kbps throughput); future alternatives are WCDMA/CDMA2000 (up to 2Mbps) and LTE (up to 1Gbps). The appropriate choice for WAN technology will likely be made on the following criteria: availability, price, throughput, latency and indoor coverage, with a mix of different technologies possible in the future.

### SYSTEM SCALABILITY

The scalability of a data concentrator’s hardware platform and software capability is important, and it can save a lot of engineering cost and time to market. Depending on specific utility requirements and deployment scenarios, one data concentrator could be connected to less than 100 service nodes (meters), or up to 1000 service nodes. The operating system is also required to enable easy maintenance and upgrading with new applications and networking stacks. For example, with more than a decade of development, Linux has general acceptance as the open source, royalty-free operating system with lots of rich features, also a real-time patch could be added on if needed. If Linux is needed, some low-end MCUs, not having enough internal memory space and external flash memory support, will be out of consideration. Most engineers are should seriously consider a pin-to-pin compatible MCU/MPU platform with core frequency scaled from 300Mhz to 1GHz, enabling a longer life cycle (>5 years) for the concentrator in the field.

### TEST

<table>
<thead>
<tr>
<th>TEST</th>
<th>TEST CRITERIA</th>
<th>TEST RESULT SUMMARY</th>
<th>PASS/NO PASS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CENELEC compliance with PRIME</td>
<td>CENELEC pass with 3 dB margin</td>
<td>Pass</td>
</tr>
<tr>
<td>2</td>
<td>PRIME signal injection on 2 Ohm load &gt; 1 Vrms with 100% duty cycle</td>
<td>Measured =1.02 Vrms on 2 Ohm load</td>
<td>Pass with 1.02Vrms</td>
</tr>
<tr>
<td>3</td>
<td>EVM Tests</td>
<td>18dB EVM at the room temp</td>
<td>Pass (0 BER with uncoded DBPSK, 18dB EVM)</td>
</tr>
<tr>
<td>4</td>
<td>Sensitivity tests</td>
<td>82 dB attenuation for PRIME 8PSK (spec = 60)</td>
<td>Pass (PRIME Tested at 83dB attenuation)</td>
</tr>
<tr>
<td>5</td>
<td>Maximum input level</td>
<td>Max input level of 123 dBuV to receive uncoded 8PSK</td>
<td>Pass (1.28Vrms input, uncoded DBPSK coding is ok)</td>
</tr>
<tr>
<td>6</td>
<td>ARIB mask</td>
<td>ARIB conducted emission passed with 3dB margin</td>
<td>Pass</td>
</tr>
</tbody>
</table>

Table 1: Criteria and results from a three-phase PLC data concentrator PHY test

Beyond the hardware considerations, developers need to consider the software needs for their system. In addition to full PLC software stacks, developers can use a complete implementation of the IEC 62056 DLMS/COSEM protocol stack (including server and client stacks), which allows AMI/AMR vendors to jumpstart development of data concentrators and metering head end nodes, not to mention accelerating time-to-market. Another
Data concentrators push intelligence to the edge of the grid by integrating, organizing and aggregating information from e-meters or other end equipment on the grid. An example would be metrology software, which is used to monitor voltage, current, frequency, active power, reactive power, and harmonics over the power line. Most semiconductor chip vendors can provide MCU-optimized metrology libraries.

**CYBER SECURITY AND DATA PROTECTION**

There are a couple different levels of security, each based on certain network deployment and overall security strategies that different utilities may require.

**Network security**

- This will be managed by the communication protocol itself, for example, IPSec, SRTP, ciphering (AES, DES, SHA-1/-2), etc.

**Device security**

- Includes secure boot and runtime security.
- Secure boot protects software stored in the boot image and protects device from executing unauthorized software; multiple public keys and customer keys will be involved during the boot sequence.
- Runtime security controls the management of emulation, debug, trace and test capabilities within the system. Memory pages, registers and peripherals will be configured with access levels, such as "user" or "supervisor" mode; read, write or execute mode, etc.

**Secure storage**

- This will protect the data in non-volatile peripherals or off-chip memory (vendor software/IP, or user private data).
- Also provides re-authoring support (re-encryption with device specific key).

**CONCLUSION**

Data concentrators play an important role in a modern AMR/AMI system. To design cost-efficient and future-proof concentrators, developers need to carefully consider WAN and NAN options, hardware platform scalability, software availability, and networking/data security design.

**REFERENCES:**

5. G3-PLC Alliance, available: www.g3-plc.com

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