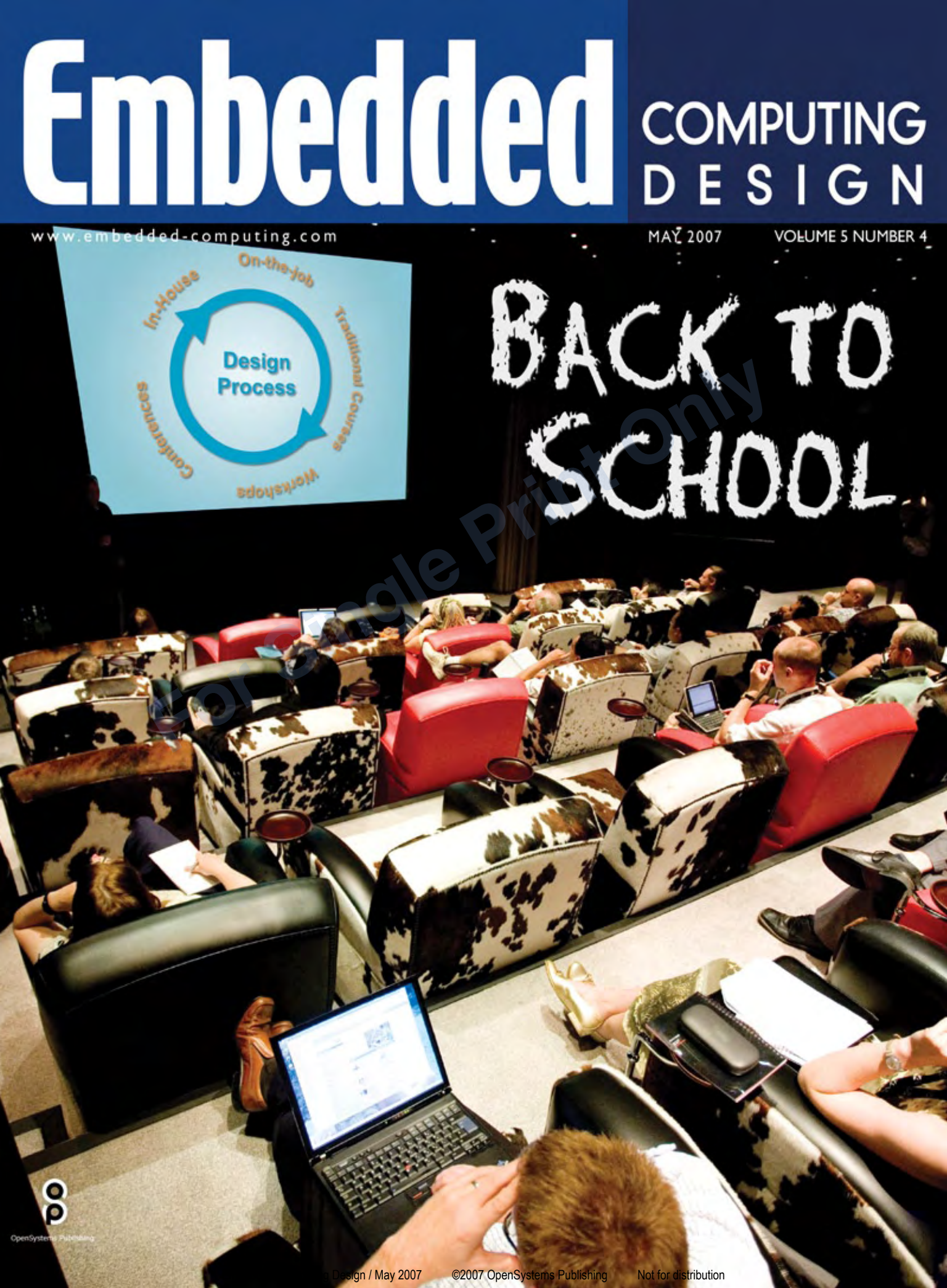
Embedded COMPUTING DESIGN

www.embedded-computing.com MAY 2007 VOLUME 5 NUMBER 4



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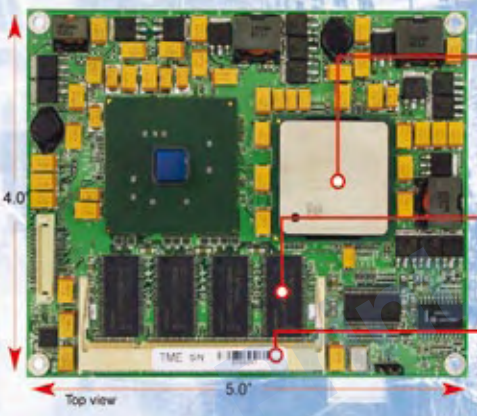

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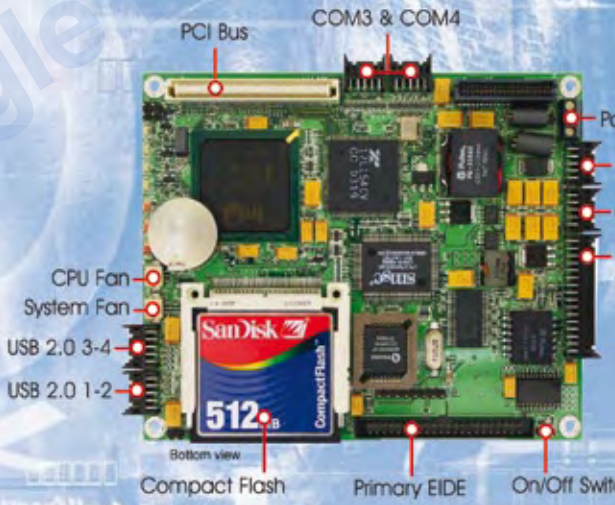

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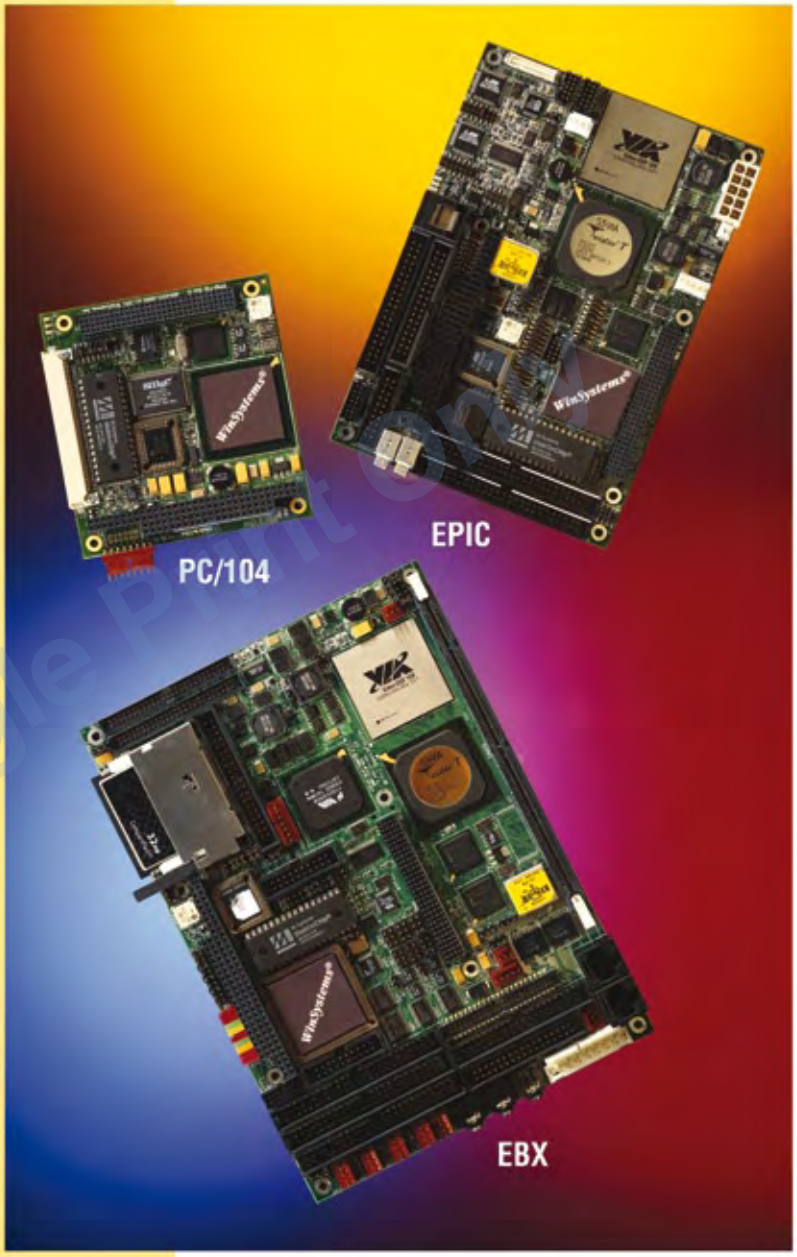

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COLUMNS

DEPARTMENTS

COVER
To stay competitive, engineers must take advantage of the resources available today and keep current with relevant knowledge. Check out the best options for continuous education starting on page 14.

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FEATURES

E-CASTS

MicroTCA: the nifty little open standard module and chassis
May 17, 2 p.m. EDT

Software gets to the cores
May 22, 2 p.m. EDT

www.opensystems-publishing.com/ecast

E-LETTER

May: **www.embedded-computing.com/eletter**
Solving the fundamental problems of high-performance software development
By William Lundgren, Kerry Barnes, and James Steed, Gedae

EVENTS

Design Automation Conference
June 4-8 • San Diego, CA • www.dac.com/44th/index.html

NXTcomm07
June 18-21 • McCormick Place, Chicago, IL • www.nxtcommshow.com

Systems & Software Technology Conference
June 18-21 • Tampa Bay, FL • www.sstc-online.org

Freescale Technology Forum
June 25-28 • Orlando, FL
www.freescale.com/webapp/sps/site/overview.jsp?nodeId=05257790361939

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Editor's Choice • Embedded Computing Design

PRODUCTS

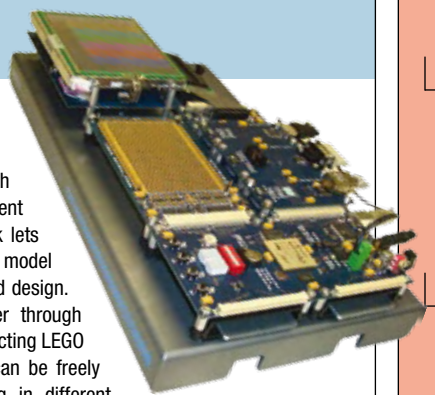
Live from inside an embedded system

Debugging and monitoring an embedded system while in development is challenging – wouldn't it be great to have a simple and intuitive interface to watch what is happening? Finally, someone has introduced just such a tool. Micrium claims to have the industry's first universal embedded system monitoring tool that enables developers to monitor systems in a live environment. Eliminating the need to stop an application to get system feedback, uC/Probe saves considerable development time by allowing users to see the internals of a running embedded application. As a result, developers can ensure the system is working properly or immediately identify system instabilities visible only when the system is live.

uC/Probe works with compilers and 8-, 16-, 32-, and 64-bit CPUs and DSPs, and can be used with any tool chain that can generate an .ELF file, doing away with the need for custom programming or scripting and thus saving additional development time. Data is displayed graphically on a PC running Microsoft Windows, and values can be numeric or shown as gauges, bar graphs, plots, graphs, LEDs, counters, or pie charts. The quality of the visuals is such that uC/Probe could be used to perform system diagnostics or as a final product user interface, allowing field technicians to monitor a device's status remotely.

Micrium • uC/Probe

Easy as building with LEGOs



Quick, easy, and simple are terms you don't often hear when designing an embedded system. Eridon Corporation has made that association possible with the release of its UnifiedLogic development framework. The UnifiedLogic framework lets designers select physical modules that model the logic needed to create an embedded design. The modules can be plugged together through universal connections, almost like connecting LEGO blocks, to model the design. Devices can be freely experimented with by simply plugging in different modules. Once the proper functionality is achieved, designers can connect to their servers to exchange the model. The servers take over and send the correct programming information back to the FPGA mounted in the UnifiedLogic framework.

Under the UnifiedLogic framework, computer-based electronics are rapidly created from self-integrating modules that encompass circuit design, supporting gate-level logic, software drivers, operating system support, and development tools. This framework allows developers to move from concept to working prototype in as little as a day. The working prototype is functionally and electrically equivalent to the final production design, further optimizing the development effort.

Eridon Corporation • UnifiedLogic Development Framework

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Virtualization, climate control, and other buzzwords from ESC

Jerry Gipper

I just got back from the 2007 Silicon Valley edition of the Embedded Systems Conference. It was a crazy week of racing from one end of the exhibition hall to the other talking to companies of all types about their embedded products and corporate strategies. More than 350 exhibitors displayed their products at this year's show, contributing to the high energy level and heavy foot traffic. OpenSystems Publishing's (OSP's) editors are excited to say that we spoke directly with more than a third of the companies represented at the show. We picked up lots of news and information that we will be passing on to you in upcoming articles, blogs, and E-letters. I would like to share some of our observations with you now.

This show could almost be called the Embedded System-on-Chip (SoC) conference, what with the huge number of SoC suppliers in attendance. Our editors can't agree on where the SoC industry will end up, but no one argues the fact that there is plenty of action in this space. The show floor contained everything from SoC IP to processors to simulation tools. All the cores are claiming to be number one, with strong showings from ARM, MIPS, and Power Architecture. Intel is even prepping to launch an Intel Architecture SoC soon. The first impression one gets is that developing an SoC is becoming relatively easy with new IP tools and rich libraries. However, it appears that soaring costs for masks would make customizing anything but the largest unit volume products very cost prohibitive. FPGAs with embedded cores seem to be the best option right now. The OSP editorial staff is trying to sort this out and will have more to say in the future.

While software still reigns as the differentiator, virtualization is becoming the "it" factor. The term has two meanings in embedded computing:

- ***Platform virtualization*** is used by companies (we call them the "V" companies: Virtio, VaST Systems Technology, and Virtutech) that offer platform simulation tools as a virtual environment to provide a development environment for application software development.
- ***Resource virtualization*** is used by Operating System (OS) suppliers as a virtual operating environment where resources are encapsulated or partitioned to provide secure and virtual resources.

All the Real-Time Operating Systems (RTOSs) have a virtualization strategy at one stage or another. The multicore processor surge, addition of virtualization technology to next-generation processors, and increased security concerns are pushing these efforts.

FPGAs and programmable logic continue to gain traction. Tools that move algorithms to programmable logic are making it less daunting for users to take advantage of the performance gains achieved through the hardware execution of algorithms. The growing list of options for logic is predicted to continue getting longer, and the tools will make programmable logic even easier to use.

Small form factor embedded boards were abundant at the show. New, smaller, and lower-power processors and SoCs are helping board designers lay out even smaller boards. VIA showed off a new ITX pico form factor board, which allows designers to put all the functionality of a PC into a very small package that lends itself well to embedded applications. The larger form factors have for the most part moved on from ESC to telecom and defense shows that attract users of those products.

While software still reigns as the differentiator, virtualization is becoming the "it" factor.

I also noticed that numerous companies at ESC launched their message into public view, using the event to debut new products. Given that the show was located in Silicon Valley, the land of the start-up, this was no huge surprise, but there were more announcements than usual. I met many new companies, including Samplify Systems, Eridon, and Future Technology Devices International. Energy surrounds these latest players and their fresh ideas.

Former Vice President Al Gore kicked off the conference delivering his keynote address on global warming with an embedded systems slant. He described the climate crisis as an opportunity to bring focus, innovation, and creativity to bear on the problem of global warming. He pointed out that the engineers at this conference are some of the best-positioned people in the world to have a significant impact on global warming solutions. The embedded technologies that you are working on can make a tremendous difference.

Jerry Gipper
Editorial Director

jgipper@opensystems-publishing.com

By Don Dingee

Software gets to the cores

One certainty in this business is watching the pendulum swing. One year, hardware gets most of the attention; the next year, software takes center stage. After a period of deafening buzz about multicore processing, the next swing seems to be heading back in the direction of software as the battlefield for competitive advantage.

It's logical that an increase in hardware complexity and capability would be followed by attempts to get software caught up and, judging from recent announcements, that appears to be the case. Designers can look forward to several new and improved software tools. Two areas – compilers and debuggers – are more traditional, while two others – virtualization and Electronic System-Level (ESL) design tools – are relatively new to embedded designers. As I head off to the Embedded Systems Conference, I've come up with a few things I see developing in these areas. And I'm sure there will be more new announcements to consider after roaming through the show.

Better compiling

Designers don't want to spend time optimizing code to run on multiple cores – they want the compiler to do that job automatically, leaving them to worry about application functionality.

New tools like the Codeplay Sieve C++ Parallel Processing System have stepped up to the challenge of optimizing software for execution on multiple cores and processors. Codeplay claims a 740 percent increase in performance from distributing a single application across an eight core Intel Xeon 5300 system with this suite.

Other designers are rediscovering OpenMP compiler technology, which was created a decade ago for high-performance computing but is now experiencing a revival as inexpensive multicore hardware becomes widely available for embedded applications. Intel and the Portland Group are two firms offering C++ and Fortran OpenMP compilers.

Better debugging

None of the processor cores in the world are any good unless designers can tell what's going on inside. Multiple execution threads running on multiple cores with complex pipelines and caching calls for very sophisticated technology.

TotalView Technologies (formerly Etnus), Lauterbach, Wind River, Mentor Graphics, QNX, Green Hills, TASKING, and others are offering enhanced tools to take on multicore platforms. One challenge is the lack of standardization among debug tools' internal parts, but selecting JTAG and Eclipse-based tools can help ease integration and reduce vendor lock-in concerns.

Better virtualization

A big server with multiple copies of an OS is one possibility for virtualization, but it can mean other things for embedded designers. Virtualization can help get the most out of a small form factor board with a dual core Intel processor by allowing two OSs, maybe Windows for the operator interface and a Real-Time Operating System (RTOS), to be used for control. Virtualization also can help the new class of media processing System-on-Chips (SoCs) with multiple processor and DSP cores by coordinating RTOS copies for the signal processing and Linux for the user interface.

VirtualLogix is making virtualization easier for embedded developers with their VLX Developer tool, bringing graphical tools to aid in configuring and managing guest OSs. Mark Milligan, VirtualLogix's VP of marketing, said virtualization "can help scale cores up, too," referring to SoCs with a variety of cores at work. (See more information on this topic in the Eclipse Perspective and News column on page 12.)

Getting the most out of the hardware by using the right software tools during development promises to be the next competitive advantage for designers.

Better system-level design

Designers can design, build, and validate software at an increasingly critical system level with complex SoCs and multicore processors. ESL tools are proving their worth quickly in helping software perform to its full potential. (Read more in our SystemC feature on page 35.)

Cadence is pushing hard in these areas, especially in the area of validation. CEO Mike Fister sees codesign with geographically separated teams as the burning platform and validation as the solution. As he puts it, "if there has to be a wall, be sure you throw only validated code over it."

Other companies like CoWare, VaST Systems Technology, Carbon Design Systems, S2 Technologies, Mentor Graphics, Virtutech, Synopsys, and others are introducing new tools to help embedded designers build better software at the system level.

Competitive advantage

With multicore processing on everyone's mind, getting the most out of the hardware by using the right software tools during development promises to be the next competitive advantage for designers. Be sure to check out this month's E-cast on this subject available at www.opensystems-publishing.com/ecast. I'd like to hear your thoughts and ideas on this and other ongoing developments in embedded technology – e-mail me at ddingee@opensystems-publishing.com.

Audio coding technology sounds good

By Hermann Strass

MP3 success continues

In May 1987, the Fraunhofer Institut Integrierte Schaltungen (IIS) in Erlangen, Germany, successfully demonstrated the first real-time audio coding implementation, dubbed *Low Complexity Adaptive Transform Codec (LC-ATC)*, which became the basis for modern audio coding algorithms. The development actually started in the 1970s with the goal of compressing music for transmission over phone lines. Today, we know this coding as MPEG-1 Audio Layer 3, commonly referred to as MP3.

Today, MP3 codecs process the audio stream in real time, whereas during the 1980s, high-performance computers would have needed hours to perform the same algorithms. MP3, which became a standard in 1992, can compress audio down to 10 percent of its original data rate or storage capacity without perceivable audio quality loss. Though developers at the time did not put much effort into patenting and commercializing this embedded technology, Fraunhofer IIS and Alcatel own the MP3-related patents.

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Innovative audio compression

A recent follow-up to MP3 and MP3 Surround is *MPEG Surround*. Agere Systems, United States, and Philips, The Netherlands, partnered with Fraunhofer IIS to standardize MPEG Surround, which was demonstrated recently at the world's largest GSM fair, the 3GSM World Congress in Barcelona, Spain. MPEG Surround can carry 5- or 7-channel surround audio at a bit rate of 64 Kbps or less. Digital video (DVB-H) and stereo sound (5.1 MPEG Surround) can be transmitted and decoded by portable players that contain an embedded microprocessor running software developed by Fraunhofer IIS. Software development kits are available to develop MPEG Surround for applications in mobile phones or on platforms like ARM, Blackfin, MIPS, or TI C55/64/67.

Spatial audio coding, a parametric coding technique, is used to generate extremely compact stereo sound in surround quality. MPEG Surround can produce multichannel surround audio without requiring several different loudspeakers in a 3D setup. The stereo sound is calculated in real time while playing music. Scalable to Lossless (SLS) coding can scale compression to available transmission bandwidths up to nearly lossless coding for streaming and professional applications. *MP3 Stereo eXtended (SX)* adds surround audio to stereo audio at bit rates comparable to legacy MP3 without changing the original MP3 (see Figure 1, courtesy of Fraunhofer IIS).

Figure 1

MPEG Surround is backward compatible to existing MP3 technology and can be used in combination with MPEG-4 High Efficiency Advanced Audio Coding (HE-AAC) and MPEG-4 Advanced Video Coding (AVC)/H.264. This is currently the highest-performance video coding method for HDTV or IPTV. Fraunhofer IIS offers server and receiver solutions in the form of PC software for floating-point and fixed-point microprocessor platforms. Chip and device manufacturers can then develop mobile TV equipment with the highest-quality video and surround audio. This software can also be used with DMB, DVB-T, DAB, IPTV, HD Radio, and MediaFLO.

MP3 and MPEG Surround are examples of truly embedded computing. The highly integrated microprocessor and software solution is deeply embedded in the MP3 device hidden from users' view by an easy-to-use interface like an iPod or Hi-Fi music system. Users do not have to buy computer hardware or software, nor do they have to install, load, update, or start a program (except on the host PC). They can simply use the device and enjoy high-quality music and video.

For more information, contact Hermann at hstrass@opensystems-publishing.com.

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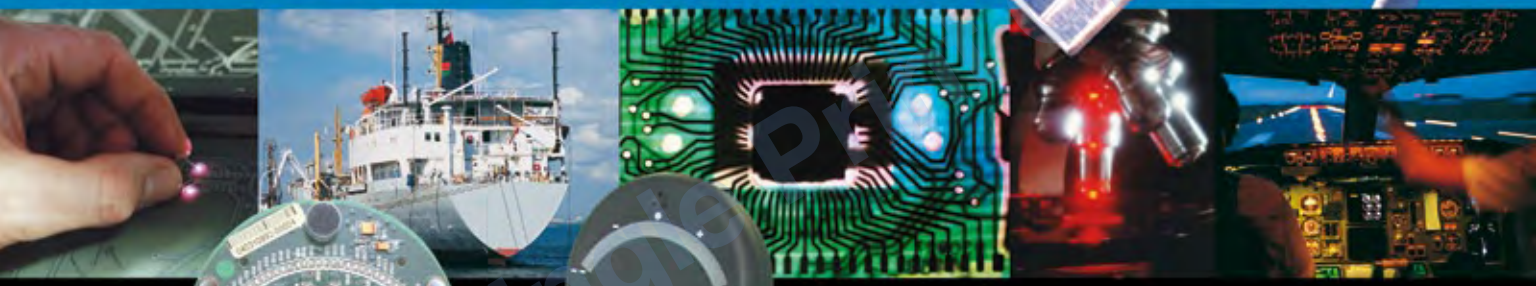

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Eclipse tools hit new hot spots

By Don Dingee

Eclipse tools for embedded C++ and Java development are now commonplace. But as a sure sign of how Eclipse technology is going mainstream, new Eclipse tools for other languages and different types of applications are popping up, including two examples that show Eclipse taking on new areas.

Aonix helps launch ADT project

Aonix is leading a new Eclipse-based initiative to create an Ada Development Toolkit (ADT) project and will collaborate with the Eclipse Foundation toward that end. With this new initiative, Aonix is offering the open source community its Eclipse plug-in technology and has proposed that the Eclipse Foundation use AonixADT in the ADT project as the core baseline technology. Opening AonixADT to the user community through an authorized Eclipse project will provide the Ada community free access to the open and extensible AonixADT solution.

Because AonixADT can be used with a large set of existing plug-ins for third-party tools, including support for source-code configuration management, it is a powerful application-building enabler. Aonix, an early participant in the Eclipse open tools movement, has provided ADT plug-ins for Aonix and GNAT compilers since 2004. With Eclipse Foundation sanctioned Ada plug-ins, the Ada community has even better options for development.

Opening AonixADT to the user community through an authorized Eclipse project will provide the Ada community free access to the open and extensible AonixADT solution.

In our April Eclipse Perspective and News column, we heard about advances in the C Development Tools project. The ADT project strives to bring similar benefits to Ada users. “We’re very pleased with the offer from Aonix to lead an ADT Project initiative,” said Doug Schaefer, QNX Software Systems, Eclipse CDT Project Lead. “Adding Ada to the Eclipse list of supported languages is further evidence of its broad acceptance as the best possible cross-language, cross-industry development IDE.”

The ADT project benefits any organization using popular Real-Time Operating Systems (RTOSs) that support Eclipse in their development toolkits. Plug-ins built on a standard ADT project baseline would work together with other standard Eclipse plug-ins supported by products such as Luminosity from LynuxWorks, Momentics from QNX Software Systems, and Workbench from Wind River Systems, to name a few.

AonixADT provides Ada project awareness, an Ada language-sensitive editor, Ada language compile and build capabilities, and a complete Ada debugger interface. ADT project awareness allows full library hierarchy manipulation, and Ada program units can be conveniently inserted or removed from Ada projects. The language-sensitive editor provides complete language awareness with syntax color coding and template completion. Symbolic debugging is integrated within the Ada language-sensitive editor. The build interface offers complete access to the Aonix ObjectAda compile and build capabilities.

VirtualLogix introduces easier-to-use virtualization tools

VLX Developer is an Eclipse-based graphical environment helping designers configure, build, and optimize virtualized platforms in which multiple Operating Systems (OSs) and their associated application stacks are consolidated onto shared hardware. Using an environment developers are familiar with simplifies virtualization integration into existing development processes.

VLX Developer provides a step-by-step process to define key hardware and software aspects of configuring and building multiple OSs within a virtualized platform. In addition, the tool’s monitoring capabilities help developers analyze and tune hardware resource allocation to the OSs, resulting in an optimal system design.

Previously, VLX contained command line level controls for system configuration and build. The addition of a graphical environment allows developers to accomplish the following tasks quickly and easily while monitoring and displaying data performance:

- **Configuration:** Allows different guest OSs to be configured with respect to memory partition, root file system, console output, and other parameters
- **Build:** Allows developers to select each component of the system, such as an OS, the virtualization engine, or a root file system, then build each component and link the components together, resulting in a system memory image
- **Monitor:** Provides a graphical display of the CPU usage for each OS running on the platform and the time spent for each context switches between OSs, enabling users to evaluate, optimize, and qualify system-level performance aspects of their virtualized platforms

VLX Developer tools provide preconfigured system profiles and defaults while enabling developers to adjust and add new parameters easily. VLX Developer is available either as an Eclipse plug-in or a stand-alone rich client platform program.

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Forever learning for engineers

By Jerry Gipper

"The rate of technology change is unprecedented. The half-life of an engineer's knowledge is estimated to be between two to seven years and generally accepted to be less than five years. And it will continue to accelerate. If it becomes less than five years, certainly less than four, we start to get scared. Half of what students did the first couple of years may or may not be relevant. The goal is to at least have it current the day that they graduate."

– Professor Leah Jamieson, Dean of Engineering, Purdue University, during the keynote address at DesignCon 2007 (www.designcon.com/2007/wed_keynote.html)

The total accumulated *scientific knowledge* of humankind is currently doubling about every five years. An International Data Corporation report released this year suggests that we produced 161 exabytes or 161 x 10^{18} bytes of data in 2006 (taking duplicates into account). Ignoring duplicates, the figure is closer to 50 exabytes of raw data. The total number of words ever spoken by all human beings is estimated to be about 5 exabytes. Given these statistics, it is evident that information and knowledge keep piling up.

What's driving this relentless knowledge growth? Professor Jamieson cited new technologies emerging at an incredible pace and the need to effectively communicate across multidisciplinary technologies as two factors contributing to this growth. With all this knowledge accumulating over time, staying up to date in one's own domain presents a challenge. Fortunately, engineers have many ways of keeping well-informed within their areas of expertise. Options include graduate school, in-house employer training, technical seminars, workshops, conferences, professional societies, and lots of reading (see Figure 1). Forever learning is a never-ending task engineers must undertake to stay competitive.

The Internet takes learning to a new level with its increased access to information and tools that can keep engineers in the know. Internet education can begin with research and reading and scale all the way to interactive online classroom environments. And though the Internet is a great tool, it is just one of the many resources for ongoing instruction. Engineers can take advantage of these resources and tools to keep current with relevant knowledge. Let's take a look at some of the top continuing education sources for engineers.

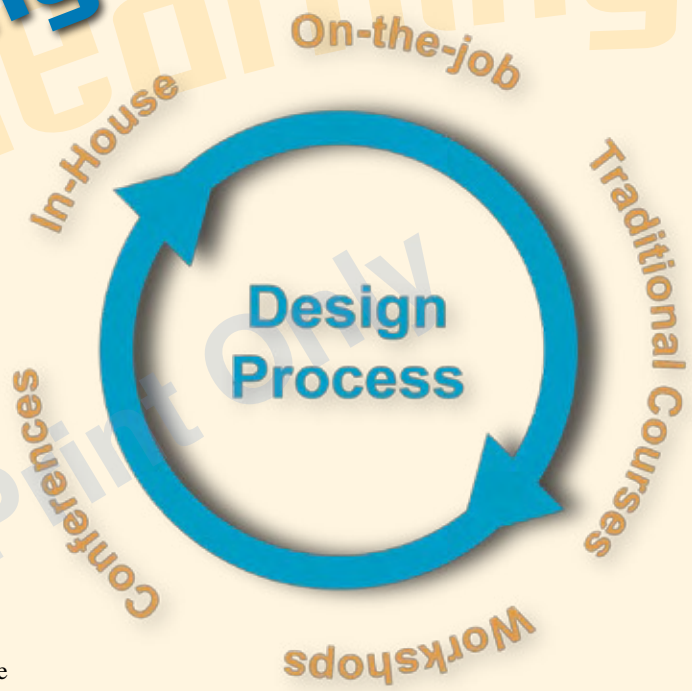

Figure 1

Even higher education

Universities, colleges, and technical schools provide an excellent place to start the learning process. Most schools offer several resources to help alumni and companies sustain continued learning. Coursework is presented online, via local television broadcast, on campus, or on-site and may be customized to fit each individual's or company's needs. Online curriculums are very common and offer the ability to view lectures, join discussion groups, view notes, do labs, take quizzes and exams, and talk to instructors. In addition, short courses, seminars, certificate programs, and workshops cover traditional and emerging engineering, technical, and management fields. Research seminars, archived lectures, and presentations on a

broad range of topics are available online via streaming video. Start with your local college or alma mater and go from there.

Technology companies often jump at the opportunity to work with universities and get their tools and products into students' hands. University support programs assist with funding, curriculum, and equipment to ensure students have access to the latest technology. However, the role of universities could be changing for the engineer of 2020. "Universities are great at teaching circuit designing, but how do you teach innovation, flexibility, decision making, change management, work ethic, and lifelong learning?" Professor Jamieson asked. Educators are currently facing this dilemma, which is being addressed primarily by the corporate world. Over time, the responsibility to teach these concepts could shift to academia.

In her keynote address at DesignCon 2007, Professor Jamieson emphasized "learning by doing instead of learning by listening." One proposal suggests that universities should investigate ways to make learning more interactive with the work environment. The engineer of 2020 can expect to see continuous learning embedded deeply into the engineering experience. For additional information on this topic, check out these reports from the National Academies Press (www.nap.edu): "Rising Above The Gathering Storm: Energizing and Employing America for a Brighter Economic Future" and "Educating the Engineer of 2020: Visions of Engineering in the New Century."

The inside track

Everyone is familiar with in-house training. This includes new employee orientation and technical skills, leadership, internal policy, and motivational training led by internal staff or contracted training organizations. In-house training staff typically develops and customizes training information to meet the company's needs. Intel University is a worldwide training organization that focuses on Intel culture, career and manager development, and new employee orientation and integration. Intel University is just one example of the hundreds of corporate employee training programs out there today.

Suppliers, distributors turned teachers

Much of the technology and tools design engineers use is very complex. Understanding how to use the technology and becoming productive with the tools takes training and experience. Suppliers offer different types of training for their products to help engineers accelerate through the product's learning curve. The training can be presented as extensive classes, condensed seminars, or workshops that cover the high points of the technology or product. The cost for this type of training can range from free to several thousand dollars, depending on the type and depth of the training. (See Table 1 for more training format comparisons.) Sometimes seminars and workshops can be a bust with too much of a marketing twist, and sometimes they can be an information gold mine. You can take your chances, but remember that the price of admission does not always equate to value. Be sure to check out the presenters' credentials if possible.

	Seminar	Workshop	Class
Level of detail	Light	Medium	Heavy
Cost	Free to low	Free to medium	Free to high
Trainers	Marketers	Engineers	Professional trainers
Purpose	Create awareness	Hands-on experience, try before you buy	How to use, increase productivity

Table 1

Open notes, open courses

A collaboration of more than 100 higher education institutions and associated organizations from around the world has created a body of open educational content using a shared model. The OpenCourseWare Consortium (www.ocwconsortium.org) aims to advance education and empower people worldwide through OpenCourseWare, a collection of free courses shared by more than 100 institutions.

To participate in consortium activities, an institution must commit to publishing materials under its name from at least 10 courses in a format that meets the agreed-upon definition of an OpenCourseWare. An OpenCourseWare site:

- Is a free and open digital publication of high-quality educational materials organized as courses
- Is available for use and adaptation under an open license
- Does not typically provide certification or access to instructors

Serious game play

Persuasive Games (www.persuasivegames.com), an independent game studio, influences players to take action through game play. Unlike other media, games deliver messages and simulate experiences. Though traditionally thought of as just leisure activities, games can also become instructive tools. The military has used "war games" for years to train troops. New simulations games can bring game play into the realm of high-technology training for engineers.

A movement with a similar focus, the Serious Games Initiative (www.seriousgames.org), was founded in 2002 at the Woodrow Wilson Center for International Scholars in Washington, D.C. The initiative's goal is to help usher in a new series of policy education, exploration, and management tools utilizing state-of-the-art computer game designs, technologies, and development skills. As the number of games used for nonentertainment purposes increases, the Serious Games Initiative is trying to organize and accelerate the adoption of computer games that can help policymakers, corporate executives, and high-tech workers address today's challenges.

Today, many suppliers offer training through webcasts. This saves on travel, and because webcasts are often archived, engineers can adjust the learning experience to match their schedules. However, a live experience still has many benefits. Hearing questions and answers and participating in discussion within a larger group setting gives engineers a chance to gauge the technology by monitoring others' feedback. Meeting with industry experts face to face creates the opportunity to gain inside information not available through other means.

Distributors are also jumping on the training bandwagon. "Training is a big value-add for Avnet," said Tim Barber, VP of Avnet Electronics Marketing. "Customers have huge time pressures, so they like to go to total-solution training events where they can learn about a lot of topics in a condensed fashion all at once."

Times have changed in the distribution channels, as distributors are now gaining earlier access to technology and can develop courses for design engineers. Distributors such as Avnet also have their own design teams build reference boards. Avnet designers can share their own designing experiences with their customers, showing them the pitfalls to be aware of during a design. Often, the distributor's design experience is broader in scope than the supplier's. Suppliers typically have a narrow vertical focus, applying their own electronic components to the solution, whereas an Avnet design uses a wider variety of components from more suppliers. This provides a real-world type of design experience that can be beneficial in the training courses Avnet developed.

Suppliers like the distribution approach to training because it provides access to the customer base. Distribution primarily focuses on shorter, half-to-full courses to show how to start the design and what the

Meeting with industry experts face to face creates the opportunity to gain inside information not available through other means.

Vendor-specific tool training

Embedded Planet (www.embeddedplanet.com) is a prime example of a technology company that offers training with their products. "With the increasing complexity of embedded systems software and the rapid adoption of Linux in the embedded systems community, our customers have been asking us to provide a broader set of system solutions and capabilities," said Embedded Planet CEO Mark Lowdermilk. The company added more training and consulting capability to their services to help OEMs get to market quickly, demonstrating an understanding that a knowledgeable engineer becomes productive much quicker.

Another company helping prepare the next generation of engineers, The MathWorks (www.mathworks.com), collaborates with universities and other industry partners and offers funding, mentoring, and software to several student competitions that focus on automotive, communications and signal processing, systems biology, aerospace, and image processing applications. The company also offers a program to keep developers informed about new technologies and how-to courses to make developers more proficient with The MathWorks tools like MATLAB and Simulink.

Engineers need to keep up-to-date on the latest technologies and software innovations to be effective at their jobs. By continuing to learn about industry-standard tools through programs such as those offered by Embedded Planet and The MathWorks, engineers can stay current in their fields.

designer needs to get the job done. Suppliers offer detailed courses for designers that need more in-depth knowledge.

Avnet breaks training into three types:

- ***Onramp*** is focused on a specific customer in a geographic area. A short course is brought on-site and usually covers new products and technologies from sponsoring suppliers.
- ***Speedway*** is a hands-on environment offered either on-site or in a local geographic area. Subject matter experts are often brought in to conduct this training, which may last up to a day.
- ***X-Fest*** is similar to Onramp except that it is typically a global event and broader in coverage. Several sponsoring suppliers participate in generating training material tuned to the local audience. Several courses are held during the day at each venue. In an intense, single-day format, design engineers can connect with multiple suppliers to explore the latest breakthroughs in technology.

Professional help

Professional societies such as IEEE (www.ieee.org) and the International Engineering Consortium (IEC, www.iec.org) provide high-quality educational opportunities for engineering professionals via events, publications, and online education. These organizations work closely with the academic and corporate worlds to ensure their members have access to the most relevant material.

IEEE has a complete continuing education program (www.ieee.org/web/education/Continuing_Education) that includes IEEE short courses, society education offerings, university and corporate partner programs, certificate programs, speakers, consultants, online learning resources, print materials, and conferences. Continuing education units and professional development hours can be obtained through many of these programs. The IEC works closely with the academic community to ensure the right learning tools are in place for engineers.

Incentives encourage education

To promote continuing education, companies often offer eligible employees reimbursement for work-related coursework, certificates, and degree programs. Courses usually must have either present or future job applicability and must be conducted at accredited schools. Some companies are generous in sending engineers to conferences and workshops so they can stay aware of the latest knowledge in their industry and areas of expertise. Incentives like this should be leveraged as much as possible. Keep in mind how fast the world is changing and make learning a number one priority.

ECD

The perfect combination for life on the edge: new access blades empowered by Linux

By Steve Wigent

Linux is gaining a substantial share of the embedded market partly because of its success in the enterprise/desktop market. With a fully supported ecosystem, full set of development tools, and backing from the massive open source movement, Linux is particularly well suited to leverage today's high-performance network edge hardware because it provides a less expensive, less cumbersome, and more flexible solution than traditional Operating System (OS) and development environments. Steve discusses how new applications driving changes at the network edge can take advantage of the benefits Linux has to offer.

Applications driving the edge

The familiar, ever-present requirement to increase density exists at the TDM edge of the market. This requirement is driven by customer demand for more calls and transactions in a smaller footprint – all faster with better quality and resulting in increased calls carried by wireless and wireline networks. However, information and identity theft as well as call monitoring, tracking, and interception present major security concerns to the VoIP world and anyone designing for the access edge market.

The wireless market at the edge is now far beyond the traditional telco and even the IP portion of the network. As designers deal with the concept of mobility, which is still relatively new, load balancing and density become huge issues as users move from place to place. Emergency services such as 911 also pose a major concern. In addition, wireless networks are looking at more than voice calls; large applications such as mobile Internet, photos, and music are all examples of what the average mobile user increasingly considers to be standard features. The load is local but also has huge bandwidth fluctuations in incrementally larger sizes.

Point-Of-Sale (POS) is another key edge application. Although POS has existed for many years, it is now rapidly growing as more POS devices become connected. For example, customizing POS programs such as credit cards and pay-at-the-pump kiosks adds more information to the network that must be managed and transmitted at increasing speeds and with absolute accuracy.

Software-enhanced TDM/IP edge blades offer flexibility to meet end-user demands for more services, faster throughput, and greater TDM-to-IP bridging capabilities.

New hardware responses

Hardware vendors are trying to respond to these edge needs. Blade solutions are evolving rapidly and providing powerful processing solutions that also offer high-density T1/E1/T3 connectivity options. Figure 1 (next page) provides a layout overview of what a typical high-density TDM card offers today's developers.

Notice that not only does the TDM card offer 24 ports of T1/E1/J1, H.110 switching, HDLC processors, an 800 MHZ processor, and multiple PTMC sites for expansion, but it also can bridge TDM to IP via the onboard Ethernet switch. TDM/IP edge blades of this magnitude allow developers to migrate from legacy architectures to current IP-based architectures because they support TDM, PCI bus, and IP in a single design. Coupling powerful, flexible blades of this caliber with empowering development software allows these blades to act as complete gateways involving signaling or multimedia applications. Single-purpose access points are no longer key. Today's blades must be able to handle a high density of trunks, multiple protocols, and process signals at a sophisticated system level.

Designers are also working with robust processors using either multicore or multiprocessor blades. SMP cores are gaining ground in the embedded market, as are virtualization and node approaches designed for end applications. Another approach is to design system-on-a-board using either a baseboard with daughtercards for added functionality or single board designs with DSP capability on the I/O cards or WAN interfaces with embedded protocol stacks.

Enter Linux

Linux fits perfectly within this environment. It solves the requirement for a flexible, robust, feature-rich development environment that allows developers to take full advantage of today's powerful hardware while still meeting time-to-market requirements. As a single OS for many processor architectures, the Linux kernel has been and continues to be supported by multiple organizations and a growing open source movement that provides volumes of accessible software for key applications, many of which can serve as the starting point for other project-specific applications.

Linux also can scale from small to very large applications with flexible memory usage, offering a wide range of support for multiple onboard devices at less cost than traditional OS and development environments.

One of Linux's key advantages is its ability to scale to the required hardware design. For edge blade solutions, Linux works well with the variety of embedded processors that blade manufacturers use. It has many distributions with other types of architecture support familiar to embedded vendors. Well suited to multicore and multiprocessor blades, Linux is also preemptive and has SMP variants to fully utilize these processors, especially with the 2.6 scheduler. In the systems-on-a-board approach, Linux solves the communication function that peer processors need and works easily with Ethernet, USB, PCI, or PCI Express. Linux makes virtualization possible even in embedded markets. In short, it has the proven drivers, protocols, and technologies to support the aforementioned design approaches.

Figure 2 illustrates how Linux, unlike other OSs, scales from a small embedded platform up to high-compute, high-power edge applications.

High-density considerations

So how does Linux address the density question? How do we handle more processing in a smaller footprint? Linux is doing what it can to scale to meet this demand. In addition to the SMP, clusters are starting to be introduced in numerous open source cluster packages. This pulls together individual custom nodes and hands-off applications and handles workload across multiple processors. Several of the clustering mechanisms are brought in through packaging but are also built into the kernel directly. This high availability access includes Ethernet bonding and multipath access to storage.

More and more intelligent applications that handle high-density edge mediums are emerging. As mentioned, single point of access is no longer the solution; applications for edge blades are more robust and are multitasking right within the threads themselves. As paravirtualization nears the mainstream, the ability to run multiple OSs on a single blade to simplify

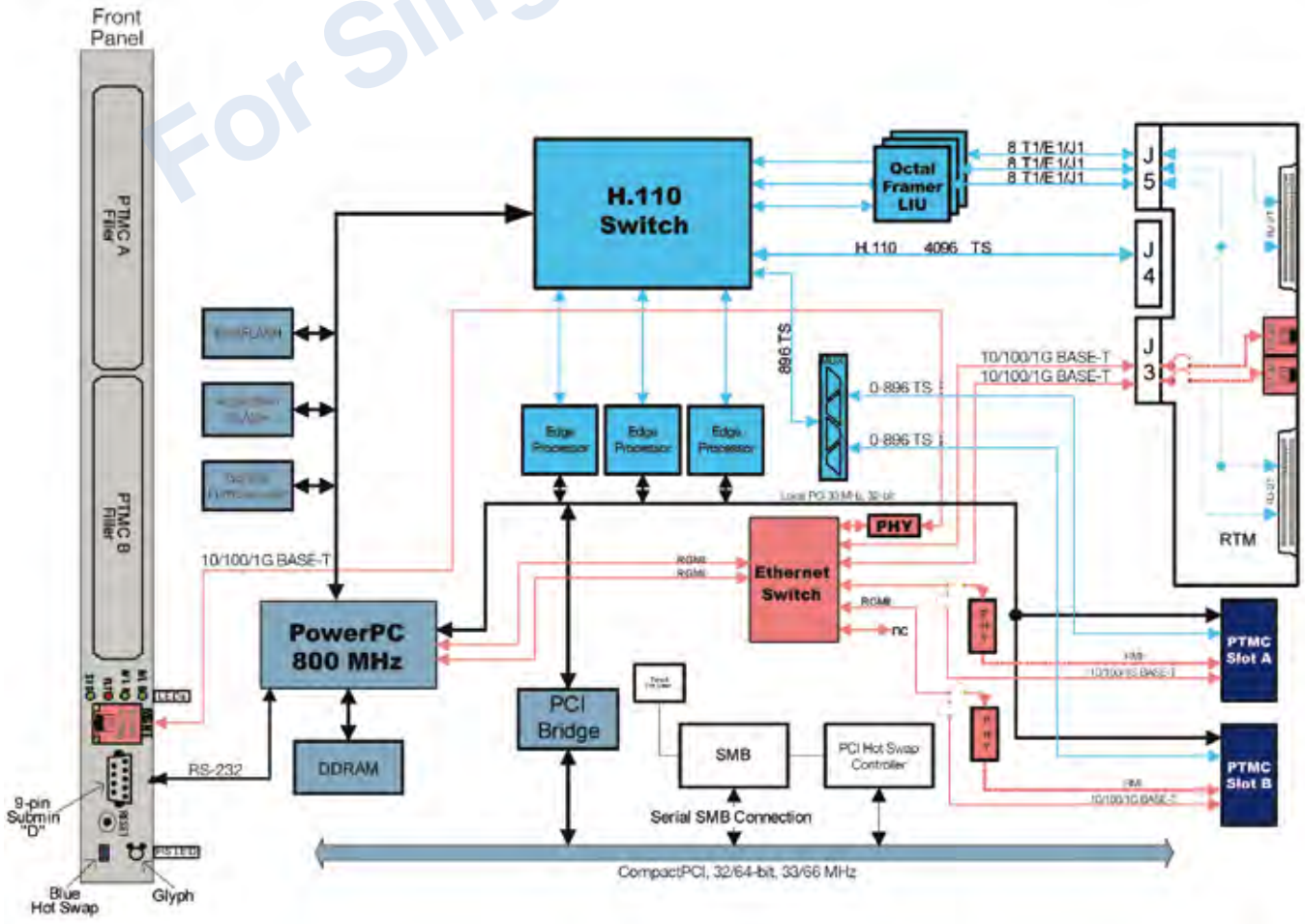

Figure 1

high-density/parallel designs is becoming essential. Xen, OpenVZ, and VMware are supporting Linux to achieve this.

When it comes to security, contemporary Linux distributions bring several benefits. The IP security realm has a Linux history with its evolution of enterprise-wide services. Embedded edge designers can see the benefits from these applications in their designs. Security Enhanced Linux is an aspect of distribution becoming mainstream, and in the encryption arena, many algorithms are now built into the kernel standard for designers to access and use in their products.

All of this points to the conclusion that Linux is a good fit for the embedded edge market. For traditional telecom, wireless, and POS applications, embedded designers can take advantage of an active *.org* resource. A variety of protocol stacks are also available, including ISDN, SS7, and SNMP. In addition, most embedded designers are already familiar with Linux-based applications. As demands move from the enterprise out to the edge, so can existing applications – and existing developers. With the abstraction Linux distributions provide, embedded C/C++ programmers can develop applications with less emphasis on *telecom expertise*.

The importance of distribution

What does the embedded designer need to look for in a good Linux distribution? All the pieces and sources are available generically on the Web in a collection of applications, installation and configuration tools, and the Linux OS. More than 250 destinations are available in CD or DVD format at a price range of $1K to $10K and up depending on the desired support level. However, be warned: the bulk of the distributions out there is desktop oriented. Leading distributions include RedHat, MontaVista, and Wind River.

Access edge application designers should be asking themselves a few key questions and picking their distribution based on an embedded applications focus. The distribution should include:

- Knowledge of embedded development tools and environments
- A clear understanding of the target hardware
- Carrier Grade Linux registration

Support for the Linux distribution should:

- Facilitate application development
- Maximize hardware/software integration
- Help bring projects to market

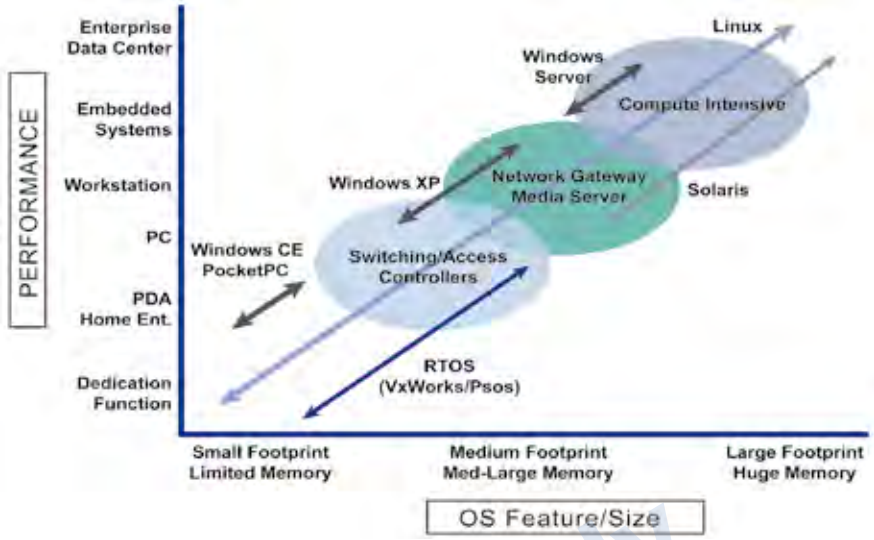

Figure 2

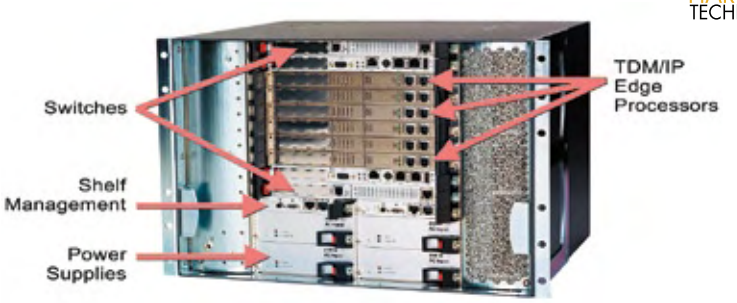

Figure 3

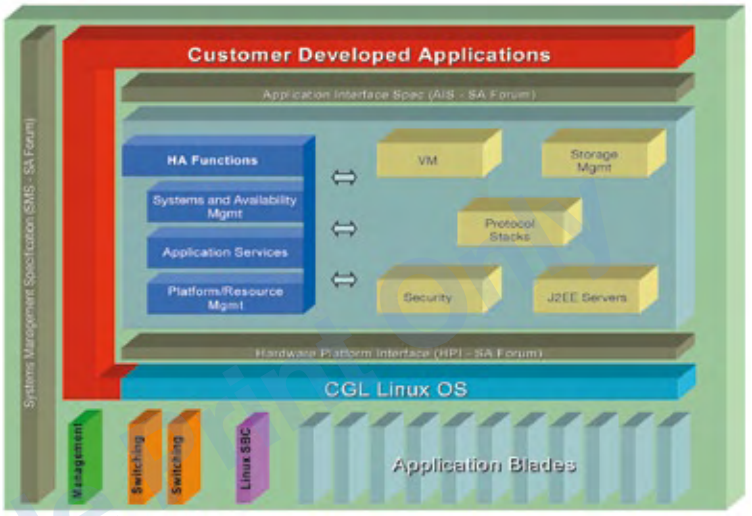

Figure 4

I/O front-end server application

Figure 3 shows a hardware platform model of an I/O front-end server that provides a mix of T1, E1, and J1 ports (TDM/IP edge processors) to the outside world that can then be packetized and forwarded to a large server upstream for call processing. This device provides not only the I/O but also interchassis management and Gigabit Ethernet switching for interchassis connectivity and uplinks to the server. This approach allows the customer to concentrate on writing Linux-based applications to enable the I/O front-end server, which may include media gateways, a billing front end, and wireless data networks.

The platform software model for a typical edge design is illustrated in Figure 4.

Flexibility essential to meet demands

In a traditional access edge network, blades often act as the access point to the network. With the advent of comprehensive applications including advanced wireless services, IMS, SMS, and IPTV, the real demand at the edge is for enhanced density. To meet these challenges, TDM/IP edge blades are now available and, paired with Linux, can provide flexibility to meet end-user demands for more services, faster throughput, and greater TDM-to-IP bridging capabilities. For embedded designers, this class of blade and Linux represents a sound choice for emerging application solutions.

A combination of empowering Linux-based software and high-density hardware can provide the most efficient density and speed required to develop complex applications such as advanced wireless services, IMS, signaling gateways, soft switches, service control points, voice messaging platforms, SMS routers, and WAN access and monitoring applications (line usage/billing and lawful intercept). ECD

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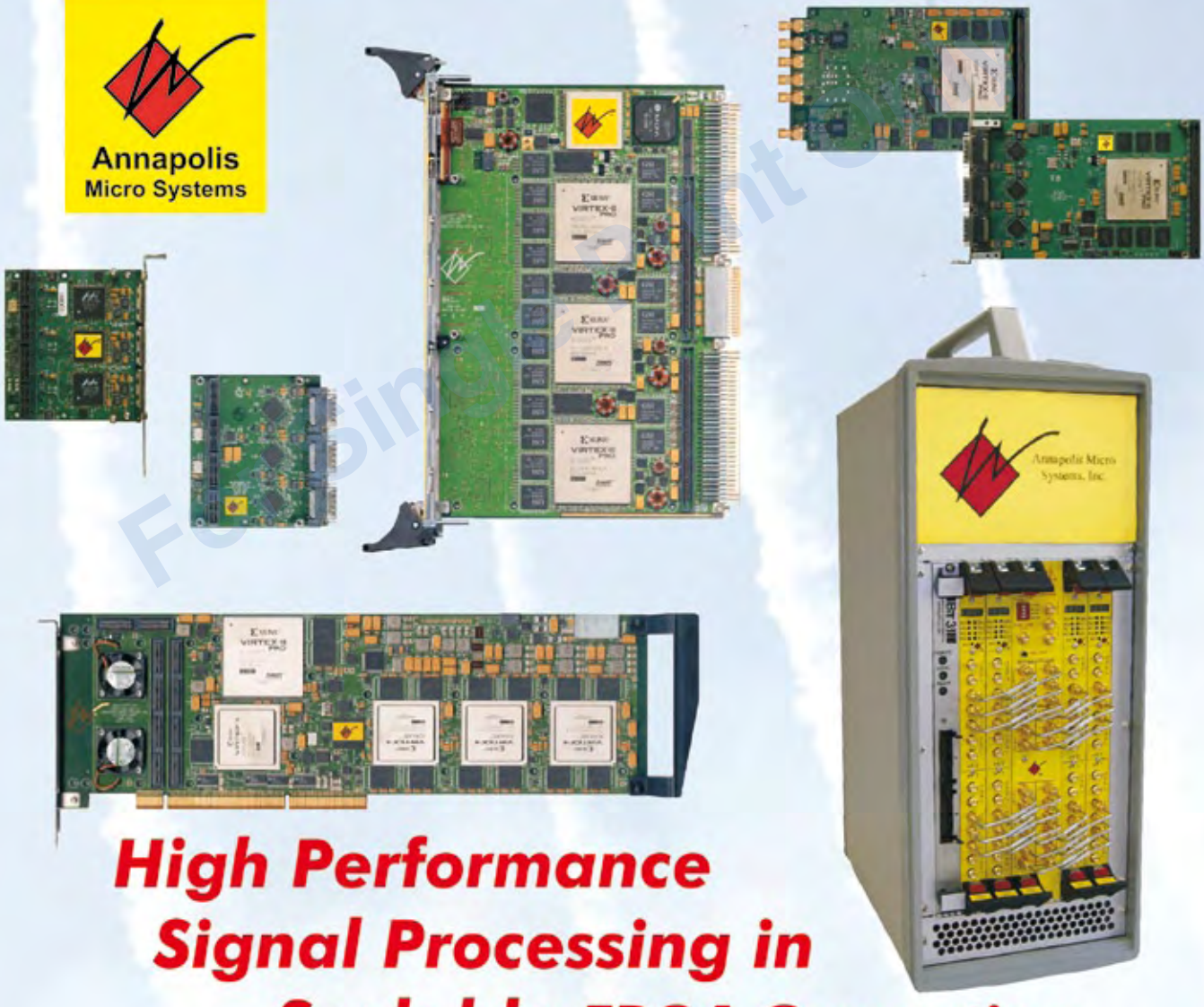

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Open source High Availability middleware liberates telecom systems developers

By Zsolt Haraszti

More than a decade ago, the telecommunications industry started migrating from in-house proprietary Operating Systems (OSs) to COTS and open source OSs such as Linux. In this article, Zsolt explores how the very same market forces are now becoming applicable to the next layers of the software stack, specifically High Availability (HA) and system management middleware.

Throughout the history of communications systems, fault tolerance and other means to building resilient platforms were the exclusive and proprietary purview of Telecommunications Equipment Manufacturers (TEMs) and, more recently, Network Equipment Providers (NEPs). After the "dark ages" of telecom in the late 1990s, telecommunications system design began to experience a renaissance with ever-increasing openness in hardware and software. Breaking with a proprietary past, TEMs and NEPs are more frequently building highly available systems from COTS hardware running open source system software. In particular, they are increasingly turning to Linux and other open source software technologies as the platform of choice for next-generation converged voice and data systems.

The move to COTS hardware and open source OSs represents the commoditization of the essential computing infrastructure. TEMs/NEPs and other Original Equipment Manufacturers (OEMs) once invested in internal resources that developed solutions from the bottom of the software stack all the way to the top, from hardware design itself to OS, to enabling middleware to systems management, to applications and service delivery. Today, such vertically integrated designs have given way to investments in adding value above standards-based and standards-compliant commodity platforms.

Open source value line

Businesses based on open source system software draw a *value line* (Figure 1) between the commodity base platform and the value-added technologies and services above it. Investment beneath this value line represents marginal activity to support a shared community resource (for example, Linux and Apache server) and offers outsourcing opportunities. Differentiating engineering and productization only occur above the value line. Open source software-based businesses must realize that the value line is dynamic and fluid, moving upward through the stack.

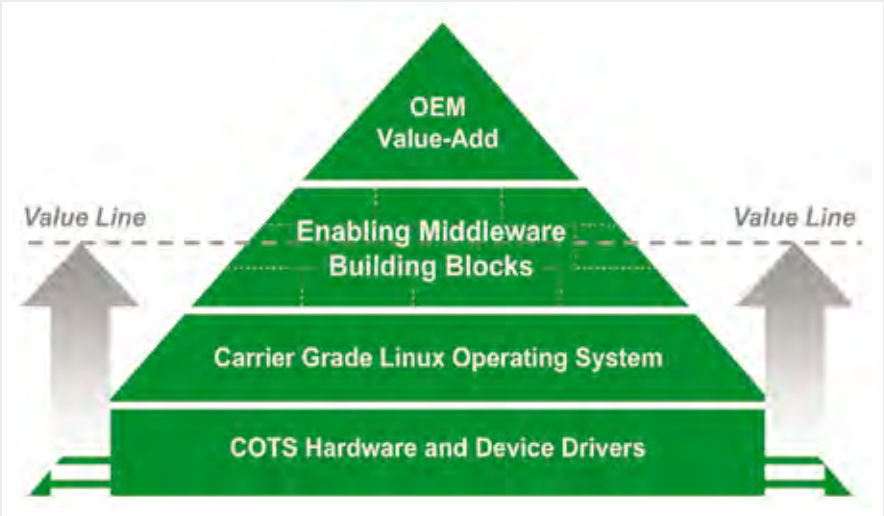

Figure 1

OEM building blocks

This transition exposes the seams in what TEMs, NEPs, and other OEMs once promoted as seamless vertical solutions. As such, communications equipment companies are actually more aligned with the value-added resellers and integrators of old; they construct voice and data systems by integrating and adding value to off-the-shelf building blocks. Their ongoing differentiation comes from unique in-house applications and service delivery vehicles, further differentiated by branding and support services.

Outsourcing system software began more than a decade ago, even before the rise of Linux and open source software in telecom. Starting in the late 1990s, OEMs shifted their traditional in-house investment in kernels and Real-Time Operating Systems (RTOSs) toward buying COTS versions of the same software from vendors such as Wind River and Sun Microsystems. The more recent move to Linux at the OS level represents a further step in this progression from proprietary commercial software to open source commercial software.

In fact, analyst firm Venture Development Corporation estimates that almost 25 percent of telecom software expenditures in 2006 were Linux based. Moreover, the Linux/open source portion of telecommunications spending is growing at 26 percent/year, much faster than the total market, which they cite at 19 percent CAGR.

High Availability (HA) middleware

Until recently, the area of enabling middleware for telecommunications closely resembled the legacy OS market. OEMs still spent unjustifiably large amounts of their budgets reinventing, developing, and maintaining completely proprietary software subsystems for fault management, alarms/notification, provisioning, redundancy, check pointing, and application infrastructure functions. When these key functions were outsourced, the technology came from a small number of Independent Software Vendors (ISVs) or software groups at Independent Hardware Vendors (IHVs). Both ISVs and IHVs, while implementing standards-based middleware offerings, did so with their own proprietary flavor or with outright proprietary paradigms and an agenda of locking OEMs into particular software and hardware schemes.

Open source Linux revolutionized the system software layer of communications systems and other embedded designs (to say nothing of enterprise servers, blades, and workstations). Now, the advent of open source HA middleware is radically changing the businesses of TEMs and, with the convergence of voice and data, NEPs as well.

By breaking away from the proprietary past and delivering open source middleware, ISVs are helping OEMs realize a range of benefits long promised but seldom delivered by *open systems* offerings.

Rapid innovation

Open source developers' motto is "release early, release often." By leveraging a core of dedicated developers, reaching out to larger groups of early adopters, and serving an ever-larger end-user community, open source projects can prototype, integrate, propagate, and field test in very tight cycles. Projects and programs can accrue new features faster and deploy with higher quality through cross-company cooperation and the power of networking.

Standardization

In-house middleware is typically designed to serve a single internal audience and gives industry standards short shrift. Single source commercial middleware is targeted at a wider audience, but suppliers often enhance standard interfaces and functionality and end up locking customers into their solutions. By contrast, open source middleware exists for a community whose members enhance and maintain it

and share the need and responsibility to interoperate. Open source software in general and middleware in particular *start* with standards like those from the Service Availability Forum (www.saforum.org), SCOPE Alliance (www.scope-alliance.org), and Carrier Grade Linux (www.linux-foundation.org) as core requirements instead of returning to standardization after the fact as window dressing.

Reduced risk

OEMs have grown accustomed to very limited warranties and near zero acceptance of liability by ISVs and other suppliers. Perhaps the greatest risk of working with proprietary software vendors is the *single source* nature of most software products. If a key software supplier is acquired, faces IP litigation, or otherwise founders financially, OEMs can lose their license to design-in and deploy critical software components, often with no legal recourse and no technical alternatives.

By contrast, open source software, as a shared resource, distributes risk across a community of developers and users. No one entity need face any risk alone, and users have the option of contracting with a supplier to warranty and indemnify against specific risks around IP, performance, and suitability. Moreover, if the company behind a project or technology changes course or goes out of business, OEMs can find alternate sources for support and services of the same code base. OEMs can leverage project community resources and choose to be self sufficient by maintaining and supporting key software themselves.

Insurance against lock-in extends beyond OEMs and helps protect carriers and operators. The standards compliance and transparency afforded by open source highlights OEM value-add and helps ensure greater interoperability among various TEMs' and NEPs' offerings.

Lower costs

Shared development + shared support – shared risk = lower costs. It's that simple. When technology development and support do not reside in a single corporate entity, everyone benefits from lower acquisition costs, standards-based interoperability, more support and service options, and avoiding single source lock-in.

Time to market

Open source middleware delivers on long-standing promises of faster time to market by accelerating evaluation, acquisition, integration, and test. Open source software by definition gives communications applications developers and integrators the opportunity to "try before you buy" with access to source code for review and prototyping. Open source software is usually less expensive than proprietary alternatives, easing justification, and has straightforward licensing terms, especially dual licensing, that simplify negotiation. OEMs' test and quality assurance departments can leverage access to the original project team and peer communities to address software bugs and performance issues in days instead of months.

Reducing costs and focusing on differentiation

Popular notions of cost reduction through free and open source software center on lower acquisition costs; actual lower costs extend across the lifetime of the software and of the organization that acquires, integrates, deploys, and supports it. A decade ago, the total software content in communications systems ran from about 100,000 lines of code up to 1 million lines. That count included OS code, device interfaces, protocol stacks and daemons, systems management and fault resilience subsystems, and the differentiated code directed at a specific application. In the intervening years, all types of embedded systems have shifted from a hardware-centric design approach to one that focuses on software and services delivered, with software content doubling annually. This dramatic growth in software means that companies must staff to meet the challenge of developing, integrating, and deploying code bases more than two orders of magnitude larger than a decade ago. Economic realities, however, dictate that OEMs find themselves with smaller headcounts.

In response to this software content explosion, OEMs began to outsource software engineering, both literally and figuratively. In particular, they *outsourced* shared hardware support and software infrastructure by turning to COTS hardware and open source software. In doing so, they further shifted the scale of software engineering involved. For example, instead of line card applications running on 5,000 line legacy RTOS platforms and managing a handful of calls, applications built on open source Linux (with 4 million lines of code) handle thousands of calls on COTS hardware blades. And while many TEMs and NEPs can boast OS expertise, their management most often chooses to build on preintegrated and tested commercial Carrier Grade Linux platforms to mitigate risk and limit marginal investment.

The same logic now applies to enabling middleware for HA. The software content in COTS HA middleware can run from 250,000 to as high as 500,000 lines of

code. Based on standard methodologies (for example, Boehm's Constructive Cost Model)[1], an OEM would need to invest at least 2,800 staff-months to create such code from scratch (under optimal conditions with at least 85 engineers working on schedule for more than 2.5 years). Even with the availability of open source software components to perform the same functions, OEMs should think twice about integrating and supporting such a code base wholly with their own resources. Ongoing maintenance for 250,000 lines of source code, even with minimal new code or patches, can occupy more than a dozen full-time software engineers.

Fortunately, communications systems developers no longer need to roll their own availability and fault resilience middleware, either from legacy internal code or from available open source building blocks "in the wild." Such a high initial and ongoing investment level justifies and is driving the trend toward shared, community-based development, with options for both community and commercial productization and support.

Open source does the heavy lifting

Since the beginning of communication systems development, equipment manufacturers were forced to invest, often massively, in building and maintaining infrastructure software that did little to differentiate their wares or add to their bottom line. The shift to COTS hardware, standard communication protocols, and open source software platforms helped liberate TEMs and NEPs from such marginal activities by outsourcing hardware and software to shared ecosystem and community resources. The heavy lifting of providing HA, manageability, and serviceability, however, still fell squarely on the shoulders of OEMs and integrators. With the advent of off-the-shelf, open source solutions such as the OpenClovis Application Service Platform, communications systems developers can now focus on differentiated, customer-driven features and functionality. ECD

References

[1] Using CoCoMo 81Intermediate Model, with input values of `size:500000, mode:1.20, rely:1.40, data:1.00 , cplx:1.15, time:1.11, stor:1.00, virt:1.00, turn:1.00, acap:1.00, aexp:0.91, pcap:1.00, vexp:1.00, lexp:0.95, modp:0.91, tool:0.91, sced:1.04`

Zsolt Haraszti *leads the product management team at OpenClovis, Inc. and has 14 years of experience in the data and telecommunications industry. He has worked at Ericsson IP Infrastructures, Inc. as a principal engineer and a software development team lead focusing on gigabit edge and blade router architectures, and at Ericsson Research, Stockholm, as a research scientist dealing with VoIP over wireless problems and communications networks performance analysis. His work has generated numerous patents and scientific papers. Zsolt holds MS and PhD degrees in Electrical Engineering from North Carolina State University.*

OpenClovis and open source

Clovis Solutions was founded in 2002 with a mission to offer communication systems vendors key software infrastructure components. Over time, the company recognized a growing opportunity to build on its R&D team's more than 400 years of collective communications systems expertise and expand it into a global community of developers, deployers, and partners.

In 2006, the company relaunched itself as OpenClovis and released its product source code as open source. Table 1 shows how OpenClovis Application Services complement and extend a Carrier Grade Linux or RTOS-based platform. Each of the layers and component types in the diagram engenders its own ecosystem and community.

Community	Component type
PICMG Communications Platform Trade Association	**Commercial off-the-shelf hardware** can mean white box PCs with AT or ATX motherboards or a range of SBC systems, but in this context, the term most commonly indicates AdvancedTCA blades with Intel and AMD 32- and 64-bit application processors. The advantage for modular telecommunications systems lies in the widespread knowledge and support for hardware also found in desktop PCs and enterprise servers. That knowledge base is enhanced and expanded by the particular ecosystems and communities built around organizations like PICMG and the Communications Platform Trade Association (CP-TA).
The Linux Foundation	**Carrier Grade Linux:** Many of today's rich and robust communications systems are deployed over versions of Carrier Grade Linux. The Carrier Grade Linux specification, now in its fourth version, was developed by leading hardware suppliers, TEMs, NEPs, Linux distribution vendors, and ISVs to provide direction for the evolution of the Linux kernel and base OS. Today, the carrier grade specification is maintained by the Linux Foundation with compliant implementations from a dozen software and systems suppliers and from community sources (for example, Carrier Grade Debian Linux).
Service Availability Forum	**Service Availability Forum APIs:** The SA Forum is a consortium of communications and computing companies working to develop and promote adoption of High Availability and management software interface specifications. SA Forum APIs provide standardized methods for systems designers and integrators to monitor and control systems chassis and other infrastructure hardware.
OpenClovis	**OpenClovis Application Services** provide a rich, open source middleware platform for building highly available communications applications. By presenting core SA Forum APIs and extended OpenClovis interfaces, developers and integrators can build on more than a dozen service types that include availability, component management, check pointing, mediation, fault and chassis management, and diagnostics.

Table 1

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Customized solution answers call recording system request

By Doug Petty

Sometimes developers just can't find the off-the-shelf call center call recording solutions they need and/or don't have the time and resources to create their own solutions. Fortunately, a few beneficial alternatives can combine internally developed and commercially available products into the right solution. Doug examines how NuComm International, a large outsource call center and customer relationship management service provider that enables clients to communicate with existing and potential customers using automated voice, resolved their call center recording dilemma quickly and effectively.

Meeting system requirements

When NuComm International realized it needed a feature-rich, highly scalable call recording solution to improve its call centers' capability and capacity, it tasked sister company NuVoxx, a computer telephony applications developer, with buying or building a specialized call recording system for deployment in the call centers. NuVoxx team members surveyed many systems currently available on the market and decided they could build a system tailored to NuComm's exact requirements faster and for a significantly lower investment than other solutions on the market. Turnkey solutions were more costly and did not necessarily have all the features their customers required.

In the early stages of system design, NuVoxx decided to base the new application on a Linux platform, giving the developers a cost-effective and stable operating system for a real-time telephony application. Although this decision would reduce overall cost and increase the system's reliability, it also would limit some hardware choices. As a general rule, more hardware choices are available in the Windows environment than with Linux. Having already selected some system components that used a specific Linux kernel, the board vendor would be required to provide software that also worked with that kernel.

The call recording application being designed was significant in size, with upwards of 30 servers to be deployed across eight geographically dispersed call centers. About 40 GB of voice information would need to be moved from the call centers into a very large, centralized 96 TB archive facility. In total, the application would have more than 130 T1 spans totaling more than 3,000 lines deployed over a high-performance telephony platform designed and built in-house.

In compliance with quality-monitoring service-level agreements with its customers, NuComm had to monitor all calls simultaneously for quality purposes. Every call to a call center would be recorded and then associated with the appropriate customer and transaction in the database. Based on the caller's account number, agent ID, call disposition, and other call details, the quality assurance team would be able to access every call that came in, review it for quality, and appropriately tailor training and coaching to their agents.

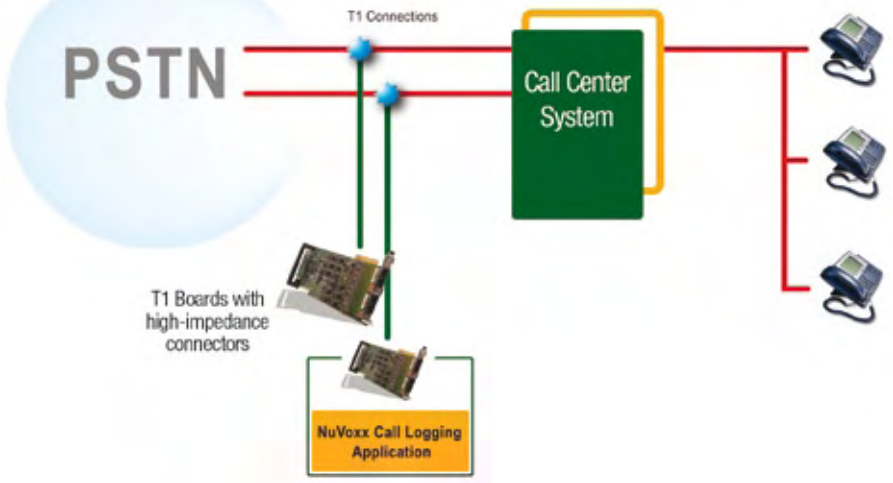

Figure 1

High-impedance connection enabled

NuVoxx selected a digital T1 board from PIKA Technologies for the call logging system (see Figure 1). This board had multiple variations on its feature set so the design team could optimize the final configuration to best meet the needs of each call center. Up to four highly flexible T1 digital network interfaces with integrated DSP resources were on each board. Passive audio tapping on T1 line interfaces using ISDN (CCS) or RBS/MFR2 (CAS) protocols was possible. Digital logging was available in single and dual span configurations with half- or full-duplex recording. The recording features included voice activity detection, time stamping, and audio compression. All of this helped pull the solution together in record time.

The call logging system is connected in parallel (passively tapped) with the T1 lines from the PSTN coming into the call center system. This ability to make a *high-impedance* connection is a mandatory feature in any call logging application of this type to prevent signal interference between the PSTN and the call center. Tapping into the trunk lines in front of the call center switch as opposed to the station lines behind the call center switch saves costs because fewer connections have to be monitored, that is, 24 trunks versus 100 agents.

When the call center system answers a call coming in from the PSTN, the call logging application running on another server is connected in parallel and collects the ISDN call setup messages. Two-way audio recording of the call can commence at any time as controlled by the application, but typically begins after an ISDN *connect message* is detected.

The DSP functionality on the digital T1 board adds the audio from both directions into a single audio stream and stores the audio in a single file. NuVoxx chose GSM as the audio compression format for two reasons. First, NuComm wanted the ability to play back calls using standard Windows applications. Second, data storage space was a factor, and GSM compresses data from 8,000 bytes per second to 1,650 bytes per second. With the flexible DSP architecture, support for GSM was added easily to the T1 boards to meet design requirements. The boards support both standard GSM and the Microsoft GSM codec 6.10. These low bit rate codecs are optimum when storage is an issue. A special version of the Linux kernel, which was also required for compatibility with other components in the call logging system, was built within a week.

As is the case in many call centers, server rack space conservation was a key consideration. As a result, NuComm wanted to deploy its call logging system in as small a form factor as possible, thus making it necessary to use a board that would handle many lines simultaneously. The T1 board's dual T1 capacity allowed for simultaneous logging of up to 48 calls on each PCI card.

More flexibility, less cost

NuComm found that developing its own solution was much more cost effective than purchasing an off-the-shelf solution and far more flexible to suit the company's specific needs. The development and hardware over several systems cost less than purchasing multiple off-the-shelf systems. A solution of this scale was no simple matter to build, but with commercial hardware and software, NuVoxx was able to integrate the voice processing component in less than two months, enabling NuComm to move from full application development to first deployment in less than four months. NuVoxx has control over the application and can integrate it with all of NuComm's other call center management systems. ECD

Doug Petty *is VP of technology at PIKA Technologies Inc. He was instrumental in spearheading Internet telephony and Web application development initiatives at Nortel Networks and has more than 25 years of related software experience. Doug is the author of numerous technical papers and holds several voice technology patents. He holds a B.Sc. First Class Honors Physics degree from the University of Calgary and a PhD in Experimental Nuclear Physics from McMaster University in Hamilton.*

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Application development assistance

As one of the hardware suppliers involved in this project, PIKA helped reduce costs and keep the project on track. On-site troubleshooting support kept R&D costs down and amortized over multiple sites. PIKA's Monte Carlo API allowed developers to add features relevant to their particular application quickly and easily. In addition, PIKA provided NuComm with sample code, which was sufficient to start with and greatly reduced time to market for the entire initiative. PIKA's Customer Care group provided assistance during the development stage to help reduce developers' learning curve. PIKA's Linux on Demand program gave NuVoxx the kernel it needed to match with the kernel that other components used.

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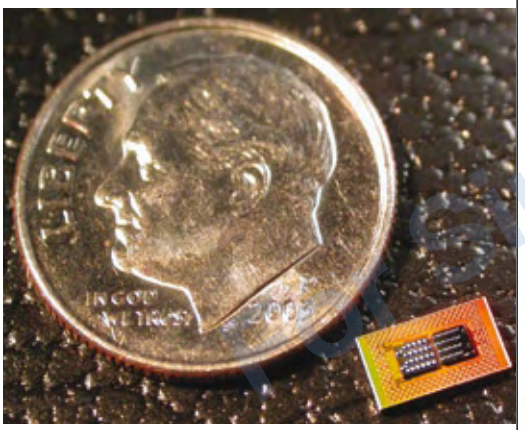
Speedy little optical chipset

The embedded computing industry has been searching for optical technology that has the speed and capability to be truly useful. IBM researchers may have discovered a solution for two of the largest obstacles to this goal – physical size and power. The research team's record-setting prototype optical chipset measures only 1/15th the area of a dime. The chip can transmit at an astonishing 160 billion bits per second. At these speeds, a full-length high-definition DVD could be downloaded in just a single second. Compare that to the 5-10 hours it takes using a typical home broadband connection.



To achieve this new level of integration in the chipset, IBM researchers built an optical transceiver with driver and receiver ICs in current CMOS technology, the same standard, high-volume, low-cost technology used for most chips today. They then combined the transceiver with other necessary optical components made in more exotic materials, such as indium phosphide and gallium arsenide, into one integrated package measuring only 3.25 mm x 5.25 mm.

This compact design provides several communications channels and very high speeds per channel, resulting in what may be the most information transmitted per unit area of card space taken up by the chipset (the ultimate measure of viability for practical use). This transceiver chipset is designed to enable low-cost optics by attaching to an optical PCB that employs densely spaced polymer waveguide channels using mass-assembly processes.

IBM Research Division
Optical transceiver chipset prototype

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SystemC: the SoC system-level modeling language

By Jerry Gipper

An SoC is literally a system on a chip consisting of both silicon and embedded software. Its design involves complex algorithm and architecture development and analysis similar to that performed in system design – a trade-off process that determines critical metrics such as SoC performance, functionality, and power consumption. Design and verification complexity is clearly on the rise.

Consequently, design tools must deliver orders-of-magnitude improvement in productivity at both architectural and implementation (RTL and physical) levels. Moreover, tools must support a methodology that enables early embedded application and system software development, long before the RTL design or silicon prototype are available. Failure to achieve the requisite improvements in design productivity would result in missed market windows and exploding design costs.

The world of Electronic Design Automation (EDA) is rapidly moving forward. As processor, board, and system designs continue to become overwhelmingly complex, it is more critical than ever that new tools emerge to make the design process more manageable. Fortunately, the industry is making progress and picking up the pace in this sector.

Increasing design capacity

Two modeling languages in particular interest SoC designers. One of the newer additions to the tool set is SystemC, which IEEE ratified under IEEE Std. 1666-2005 in 2005. The Open SystemC Initiative (OSCI, www.systemc.org) is currently driving and supporting this effort. The second tool is SystemVerilog, ratified as IEEE Std. 1800-2005 at about the same time. The Accellera organization (www.accellera.org) spearheads SystemVerilog efforts. The SystemC and SystemVerilog design and verification languages were developed to deliver exponential increases in design productivity in response to the industry's perennial challenge – continuing exponential increases in design and verification complexity. Knowing that these languages are increasingly used to complement SoC designs, what specific role does each of these play in SoC design?

SystemC was developed in response to demands for a standard Electronic System-Level (ESL) language that SoC designers using C/C++ could utilize. It is a single, unified design and verification language that expresses architectural and other system-level attributes in the form of open source C++ classes. It enables design and verification at the system level, independent of any detailed hardware and software implementation, and facilitates coverification with RTL design. This higher-level abstraction enables considerably faster, more productive architectural trade-off analysis, design, and redesign than is possible at the more detailed RT level. Furthermore, verification of system architecture and other system-level attributes is orders of magnitude faster than at the pin-accurate, timing-accurate RT level.

SystemC is purely a version of C++ that OSCI adapted and standardized for system-level design. The IEEE 1666 Language Reference Manual provides an unambiguous definition of the SystemC language, allowing EDA tool and IP developers to offer simulators, models, and system-level design tools that conform to the SystemC standard. Figure 1 shows the SystemC language architecture.

SystemVerilog, the first hardware description and verification language, is a major extension of the established IEEE 1364 Verilog-2001 language. Developed to improve productivity in developing large gate count, bus-intensive designs, SystemVerilog is targeted primarily at the behavioral-to-GDSII part of the SoC design flow. SystemVerilog also supports transaction-level modeling at the *transaction* abstraction level. This verification overlap between SystemC and SystemVerilog constitutes an invaluable design and verification link from the system level to chip implementation. SystemVerilog's Direct Programming Interface allows it to "call" C/C++/SystemC functions and vice versa, making SystemVerilog the first Verilog-based language to enable efficient SystemVerilog and SystemC block cosimulation.

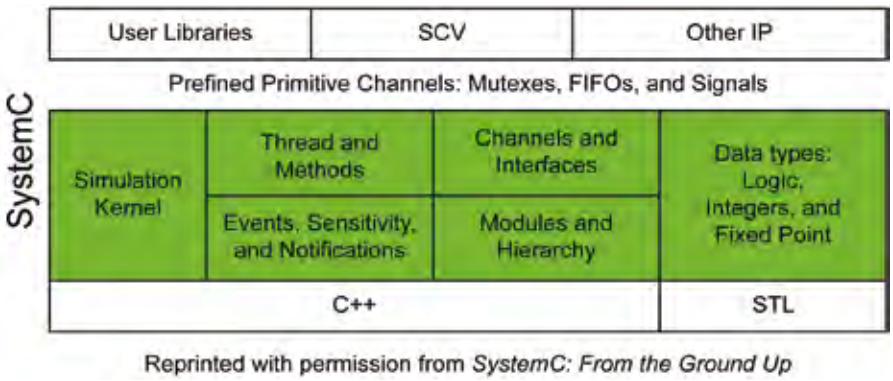

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Figure 1

Despite the two languages' complementary nature, comparative language analyses are fueling some debate that suggests designers must choose between them. But design and verification challenges have pushed mixed use of SystemC and SystemVerilog. To put this in perspective, consider that the "real" designers who work in RTL today worked exclusively at the gate level 10 years ago. SystemC does not replace RTL, but rather provides a new language to accomplish the tasks developers cannot complete in RTL. Figure 2 compares languages and demonstrates SystemC's broad usage across the tasks associated with electronic system design.

"Just like RTL is a level of abstraction that eliminates the need to worry about gates, SystemC eliminates the need to worry about RTL," said Mitch Dale, Calypto Design Systems' director of product marketing. "Each generation of tools increases design capacity." People are looking for ways to capture system-level descriptions, which include three components: models, a way to capture hardware intent, and interface with the software content.

Challenges in the hardware design community

New tools and technologies often struggle with gaining acceptance in the user community, and SystemC is no exception. For experienced hardware designers, SystemC is a new language that requires further education. Hardware designers must start thinking at a new and higher abstraction level and must learn to avoid concentrating on the details. Unlike the RTL space, where EDA tools are prevalent and readily available, the ESL design space is still being defined. System design engineers in school are more familiar with C and C++ than experienced engineers, so they might consider working with SystemC a pleasant experience.

Since the 40th Design Automation Conference in 2003, the industry has undergone a massive transition to system-level design. Now Transaction-Level Modeling (TLM), the next abstraction level above RTL, is becoming an essential area of focus. SystemC shines and system architecture and software converge at TLM and higher levels.

Design complexity is increasing so rapidly that design creation must move to higher-level abstraction. Dataquest has identified system-level design and low power as the most important design technologies, which is no coincidence considering that the available real estate on silicon is rapidly approaching 100 million gates.

OSCI to the rescue

Given the need to bring software and hardware design closer together and the numerous dialects different companies use, it was no surprise that the industry rallied behind CoWare and Synopsys when the two companies joined forces to codevelop SystemC. Most system, semiconductor, and IP companies were thrilled to see a drive toward a unified language for system-level design. Design was becoming more software-centric and IP reuse had to become a reality. A unifying SystemC would enable IP sharing at the system level and eliminate all incompatible C dialects. OSCI claims that SystemC has completely and clearly succeeded in this respect.

OSCI was launched in 1999 as an independent nonprofit organization dedicated to supporting and advancing SystemC as an industry-standard language for ESL design. Its membership grew by 30 percent in the past year, reports the organization's executive director, Pat Sheridan of CoWare. "Clearly we are seeing a surge in SystemC since it became an international IEEE standard," Sheridan said. "For large companies and individual users alike, SystemC is now a major and mainstream feature in ESL design that provides the foundation for a worldwide ecosystem that would otherwise not be possible without a standard language."

SystemC is also gaining momentum around the world, with thriving user groups in North America, Europe, and Japan and new groups that have formed in India and Latin America. The European SystemC Users Group, for example, has grown from 40 members to more than 1,000 in the past seven years, said cochair Wolfgang Rosenstiel of the University of Tybingen.

In Japan, SystemC use continues to grow. Nearly 20 percent of respondents at EDSF now call SystemC their primary design language, doubling the number reported in 2003. "SystemC is widely used in Japan as the ESL language both for modeling and verification," said Fujitsu's Takashi Hasegawa, chair of Japan's SystemC Task Group. "With the enlargement and complexity of LSI, further improvement of design productivity and quality is required, and we believe SystemC is the solution."

In addition to increased use, SystemC and OSCI have notched a series of technological achievements, including approval of the IEEE 1666-2005 standard for SystemC and the impending release of the TLM 2.0 standard later this year.

The IEEE Std. 1666-2005 Standard SystemC Language Reference Manual is available for free at http://standards.ieee.org/getieee/1666/index.html. OSCI also recommends several books to help developers become more familiar with SystemC and TLM. Expect to see major advances as SystemC gains acceptance and more IP models appear. As Dale says, "It is larger than the language. It is part of the EDA revolution!" ECD

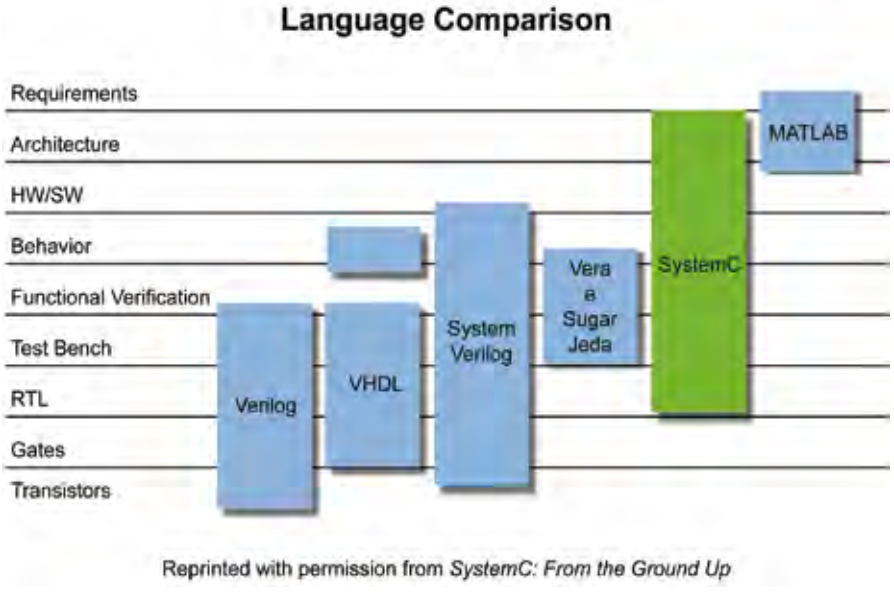

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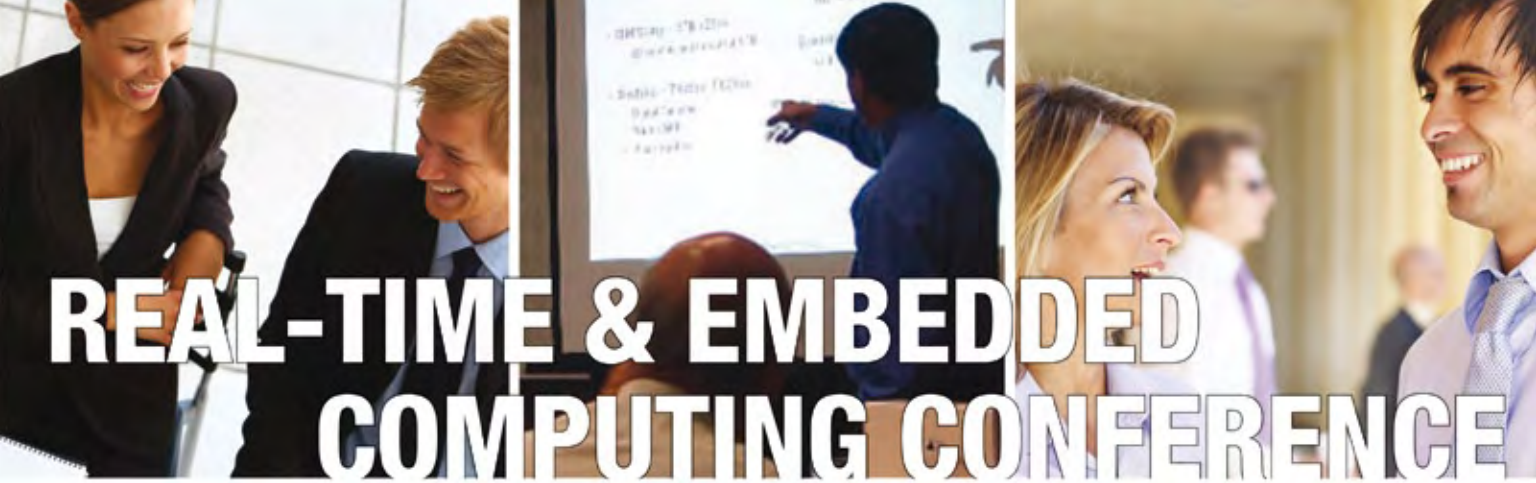
Figure 2

For additional reading:

[1] David Black and Jack Donovan, *SystemC: From the Ground Up* (Kluwer-Academic Publishers, ISBN:1402079885)
[2] Ghenassia, Frank (Ed.), *Transaction-Level Modeling with SystemC: TLM Concepts and Applications for Embedded Systems* (ISBN: 978-0-387-26232-1)



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