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Test & MEASUREMENT WORLD®

THE MAGAZINE FOR QUALITY IN ELECTRONICS

Peter Bodell, CIO, Los Angeles County Museum of Art.

The ART of WIRELESS

Testing ensures museum visitors enjoy a rich multimedia experience.

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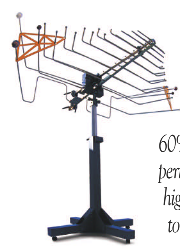

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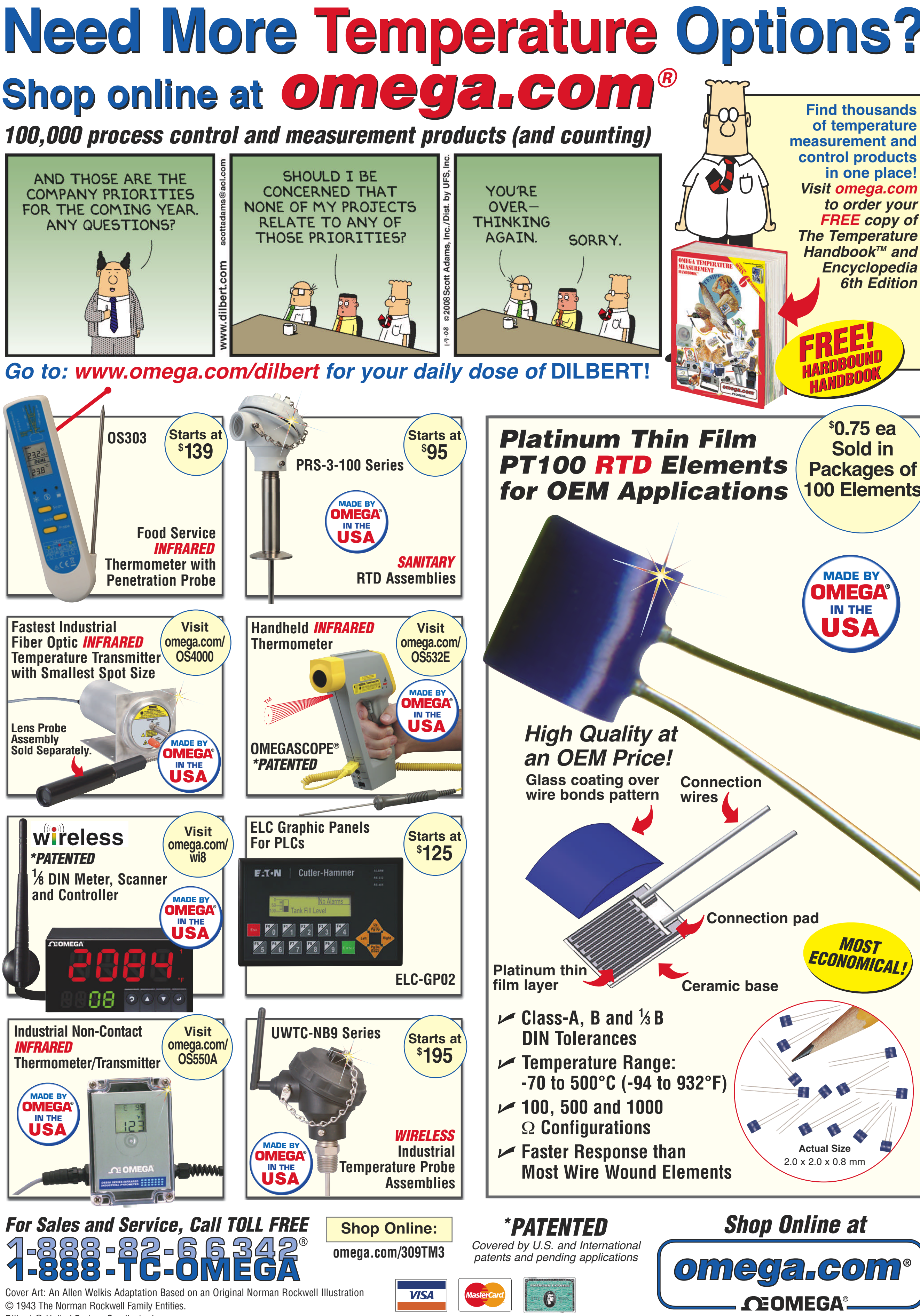

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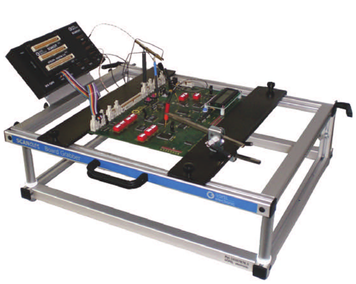

TECH TRENDS

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Check out these exclusive features on the *Test & Measurement World* Web site:

IPC's Schuld to drive assembly-technology standards

The trend toward high-density interconnects is driving the need for standards, as designers put more components into less space. To help its members deal with standards, the IPC has named Kevin Schuld as director of assembly technology. Schuld recently discussed the challenges he faces in gaining consensus among the association's volunteer members.

www.tmworld.com/ipc_schuld

Got Test Ideas?

In our monthly Test Ideas column, our readers share innovative tips that can help other engineers solve test problems. Recent articles have covered generating a swept sine in LabView, producing AC test signals, and isolating a clock source.

Check out past columns, and then submit your own idea. If you've built a custom test fixture, written code to control a signal source and a measurement instrument, or designed a circuit to get a waveform you couldn't get anywhere else, tell us about it. If we publish your idea, we'll send you $150.

www.tmworld.com/testideas

Blog commentaries and links

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Rick Nelson, Editor in Chief

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- AIA hears turnaround prediction

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- A bittersweet honor
- Launch your career with the first flying car

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EDITORIAL STAFF

Editor in Chief: Rick Nelson
rnelson@tmworld.com
ATE & EDA, Inspection, Failure Analysis, Wireless Test, Software, Environmental Test

Managing Editor: Deborah M. Sargent
dsargent@tmworld.com

Senior Technical Editor: Martin Rowe
mrowe@tmworld.com
Instruments, Telecom Test, Fiber-Optics, EMC Test, Data-Analysis Software

Assistant Managing Editor: Naomi Eigner Price
neprice@tmworld.com

Contributing Technical Editors:
Bradley J. Thompson, brad@tmworld.com
Steve Scheiber, sscheiber@aol.com
Richard A. Quinnell, richquinnell@att.net
Ann R. Thryft, ann@tmworld.com

Editorial Intern: Puneet Lakhi

Publisher: Russell E. Pratt

Senior Art Director: Judy Hunchard
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Reed Business Information-US, A Division of Reed Elsevier Inc.
CEO: Tad Smith
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CFO: John Poulin

HOW TO CONTACT T&MW

EDITORIAL:
225 Wyman St.
Waltham, MA 02451

Phone: 781-734-8423
Fax: 781-734-8070
E-mail: tmw@reedbusiness.com
Web: www.tmworld.com

SUBSCRIPTIONS:
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Customer Service
Reed Business Information
8878 S. Barrons Blvd.
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Fax: 303-470-4280
E-mail: subsmail@reedbusiness.com
Web: www.getfreemag.com/tmw

CIRCULATION:
Jeff Rovner
303-265-6266
jrovner@reedbusiness.com

LIST RENTAL:
Hector Gonzalez
630-288-8368
hector.gonzalez@reedbusiness.com

GENERAL AD SALES AND MARKETING:
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RICK NELSON
EDITOR IN CHIEF

A valentine, things, and stuff

I received a Valentine's Day card last month, having on its cover a photograph of a couple dancing on a bridge near a lamppost in what appeared to be a European city. Your obvious question might be, why would someone send me a valentine? But my question was, which city?

Google Images lets you attempt to answer such questions using an iterative approach by searching, for example, for "Budapest bridge lamppost" or "Dresden bridge lamppost." (My card turned out to depict the Charles Bridge in Prague.)

It seems there should be a more straightforward approach—instead of sorting through images returned by Google in response to text-based queries, one should be able to submit an image and get text back. Such capabilities do appear in limited contexts. Fans of mysteries will know that police officers can submit fingerprints to the FBI's IAFIS and get in return the name and criminal history of a suspect. Also, police and casinos use face-recognition systems to search for criminals or card counters. But generalized image recognition remains elusive.

Spatial context can help computers make decisions.

That may change, based on work presented by Geremy Heitz at the Automated Imaging Association's 17th annual business conference, held February 4–6 in San Diego. Heitz, a PhD candidate at Stanford, described work he is doing on high-level scene interpretation. Heitz noted that humans can readily analyze scenes—they can identify a cityscape, for example, and detect objects and establish relationships between them: "The car passes a bus on the road, while people walk past a building."

That's a tough task for computers. As an example, Heitz presented a blurred rectangle of pixels, which neither man nor machine could identify. But when he presented that rectangle in the context of a country road, it became clear to people that the rectangle represented a moving vehicle. Computers, however, have trouble dealing with context and are likely to mistake a cow standing in a meadow for a motorcycle.

To help solve that problem, Heitz is working with "things" and "stuff." A thing, he said, is an object with a specific size and shape, while stuff is a material defined by a homogeneous or repetitive pattern. Given a things-and-stuff (TAS) model, a computer can make an educated guess. For instance, given "stuff" equals grass, "thing" is more likely to equal cow than motorcycle. Heitz has concluded that spatial context gained through a TAS approach can improve any machine-vision sliding-window-detector technique.

Several attendees at the AIA meeting seemed eager to adapt the TAS model to industrial machine-vision applications, but that might be premature. If, for example, I am expecting to see a diode (thing) at a specific place on a printed-circuit board (stuff), I don't want my automated-optical-inspection system to infer "diode" if a resistor has mistakenly been placed in the diode's spot. Indeed, Heitz said typical applications for his work lie in the surveillance and security fields. Nevertheless, his work sheds light on how people analyze images, and that knowledge will likely yield techniques that have broad applicability (Ref. 1) across a range of machine-vision specialties. T&MW

REFERENCE

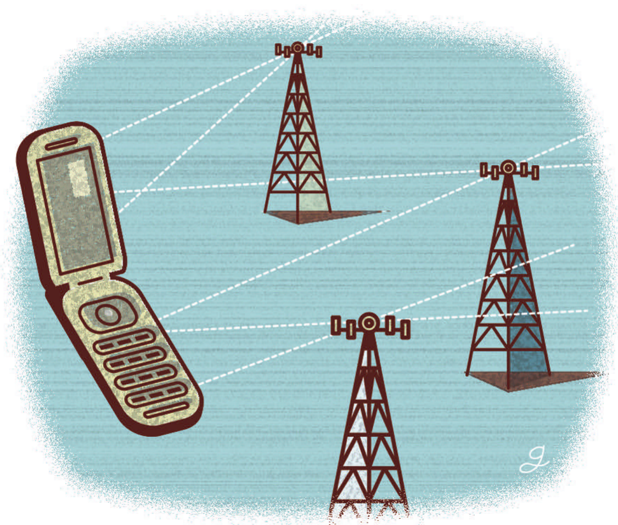
1. Lipson, Pamela R., "AOI systems simulate human brain," *Test & Measurement World*, February 2007. www.tmworld.com/2007_02.

> > > *POST YOUR COMMENTS AT WWW.TMWORLD.COM/BLOG.*

[An exclusive interview with a test engineer]

The RFIC evaluator

Joe Flynn is a staff engineer at Sequoia Communications, a start-up fabless semiconductor company that develops and produces single-chip RF transceivers for multimode cellular handsets. The transceivers enable handset manufacturers to use a single device to communicate over GSM, EDGE, and WCDMA networks. Martin Rowe spoke to Flynn by telephone at his office in San Diego.



DAN GUIDERA

Q: What is your role in test?
A: At Sequoia, four test engineers develop evaluation boards and automated test stations for evaluating designs. We also perform the evaluations and analyze test data.

Q: What's in an evaluation board?
A: In-house evaluation boards provide us with access to every signal on the device. Our device supports multiple bands and modes, which means we need to test five transmit paths and seven receive paths. We use a socketed board for functional testing and a soldered-down version for characterization. For customers, we provide a reference design board with a single antenna port that includes all of the components required to simulate the RF section of a cellphone.

Q: What are some of the tests you perform?
A: We test transmitters by feeding them a baseband analog signal and measuring the output. We use predefined waveforms built into a signal source along with proprietary waveforms and store them in the instrument. We also test receivers using modulated signals and measure any distortion that the receiver produces during downconversion. For receiver EDGE testing, we use 8PSK (8 phase-shift keying) modulated waveforms. We have many waveforms for WCDMA testing, starting with QPSK (quadrature phase-shift keying) waveforms and then moving on to more complex waveforms.

Q: How many devices do you test in an evaluation?
A: We typically test 50 to 100 pieces. That gives us enough data to characterize how the part will perform in production. We also evaluate parts from multiple wafers within the same lot. In addition, we have our silicon supplier fabricate parts using process parameters at the corners of their specifications. This provides us with data on how well the parts behave over the full range of production parameters. We also test the parts over a wide range of power-supply voltages.

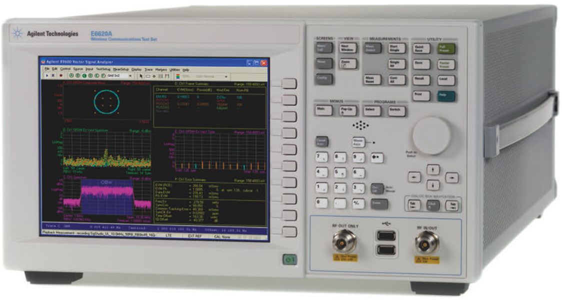
Q: How do you test for environmental effects?
A: We test our receivers in an environmental chamber that's installed in a screenroom. It minimizes interference from commercial radio transmitters and nearby cellphones and base stations. Transmitter test stations don't need screenrooms.

Q: What are the functions of your test stations?
A: We have several test stations. One tester performs functional test on new parts so we can verify that they work before we characterize them. Another station calibrates transmitter and receiver gain stages. To minimize cost and complexity, we have independent receive and transmit test stations. The receiver test station includes a vector network analyzer for measuring S-parameters and a modulation analyzer to test the baseband output of the receiver. Measurements include gain, noise figure, intermodulation distortion, cross modulation, signal-to-noise ratio, and error-vector magnitude. A digital multimeter measures power-supply current on every power pin through a switching matrix.

Q: How do you analyze test data?
A:. The test data is stored and is manipulated using a custom Web-based charting tool that allows us to compare measurements on the devices over environmental, fabrication process, and power-supply conditions. Due to the complexity of the device, we produce as many as 1200 plots. T&MW

Every other month, we publish an interview with an electronics engineer who has test, measurement, or inspection responsibilities. If you'd like to participate in a future column, contact Martin Rowe at mrowe@tmworld.com.

Agilent, Anite demonstrate LTE end-to-end streaming video



Agilent Technologies and Anite teamed up to demonstrate 3GPP LTE interoperability at the Mobile World Congress (February 16–19, Barcelona, Spain). The demonstration showed end-to-end streaming video with a Blue Wonder UE chipset, a Signalion SORBAS LTE UE (user equipment) simulator, an Agilent E6620A LTE wireless-communications test set, and an Anite SAT LTE protocol-development toolset.

The demonstration results from a strategic partnership between Agilent and Anite to deliver LTE UE development tools to wireless engineers. Said Paul Beaver, business unit director at Anite, "Our partnership with Agilent plays a pivotal role in pioneering the LTE ecosystem." Niels Faché, VP and GM of Agilent's mobile broadband division, added that the partnership addresses the early testing needs of LTE UE developers.

As a key component of the LTE streaming-video demonstration, Agilent's E6620A wireless communications test set (**pictured**) provides a common hardware platform, integrating a 3GPP release-8-compliant protocol stack (jointly developed with Anite). Helping to shorten design cycles, it offers real-time, system-rate network emulation for L1/L2/L3 uplink and downlink via RF or digital baseband. Anite's SAT LTE protocol-development toolset (commercially shipping on the E6620A platform) provides a suite of development tools for UE designers. www.agilent.com; www.anite.com; www.bluwo.com; www.signalion.com.

Aeroflex accelerates rollout of features for LTE handset tester

Aeroflex has announced that it will accelerate the rollout of the new features planned for 2009 for its 7100 digital radio test set for LTE mobile device test. "LTE is fast becoming a global phenomenon with network operators in all the current CDMA-dominated markets (US and Asia) in addition to the traditional GSM markets increasingly opting for LTE for their next-generation mobile broadband networks," said Bill Burrows, business development manager at Aeroflex Test Solutions. "The decision to accelerate our new feature roadmap for the Aeroflex 7100 is designed to support their similarly aggressive rollout plans and the demanding test requirements this places on developers designing new chipsets, protocol stacks, and devices supporting the LTE standard."

The accelerated rollout of new features for the Aeroflex 7100 during 2009 relates to LTE/CDMA2000 interworking, LTE UTRAN (UMTS Terrestrial Radio Access Network) and GERAN (GSM Edge Radio Access Network) handover, TD-LTE mode (referring to the time-domain duplex version of LTE, which China is adopting), and LTE mobile device conformance test.

"Our accelerated product roadmap for the Aeroflex 7100 will ensure that, throughout 2009, it will progressively incorporate all the additional features and functionality needed to meet the aggressive rollout plans announced by the major network

Editors' CHOICE

Lithium-ion-cell measurement instruments

Data Translation has announced its VOLTpoint series of voltage-measurement instruments for lithium-ion cell-by-cell determination. Each VOLTpoint is a stand-alone box offering 48 separate 24-bit-resolution inputs over a sampling range of ±100 V, each with its own sigma-delta ADC for direct connection to a PC via USB or Ethernet (the Ethernet version is LXI-compatible).

The instruments can make high-voltage, precision battery-stack and cell-balance measurements in commercial and military hybrid-vehicle applications. They accept direct voltage inputs of any value in the range of ±100 V from a single cell or from a series of stacked cells. In addition, the instruments can make motor shunt measurements. Each of 48 separate input channels offers 1000-V channel-to-channel galvanic isolation. Maximum error for any input range is 3 mV.

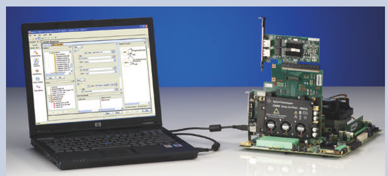
The instrument comes with the software necessary to enable out-of-the-box measurements. The vendor offers software supporting the VOLTpoint, including IVI-COM drivers, .NET class libraries, and software development kits.

Prices: DT9873 for USB—$7995; DT8873 for Ethernet (LXI)—$8495. *Data Translation, www.datatranslation.com.*

Editors' CHOICE

Add errors to the PCI bus

Agilent's N5323A PCIe (PCI Express) jammer lets you test a peripheral card, PC motherboard, or PCIe interface device by injecting errors onto the bus. The jammer, a card that inserts between a motherboard and a peripheral, is completely transparent to both. Because it's transparent, the jammer will work with any operating system running on the motherboard. With the jammer, you can inject errors at the physical layer, data-link layer, and transaction layer.



Physical errors include disparity error, drop of TLP (transaction-layer packet) start and end characters, and link retraining. Data-link errors include dropping or inserting of DLLP (data-link layer packets) and sending corrupt CRC (cyclic redundancy check) values. Transaction-layer errors include dropping, delaying, replacing, or modifying TLP packets.

The PCIe jammer lets you perform tests through a user interface with software that communicates to the card over USB. Using the Windows-based software, you can perform predefined test cases on your peripheral or motherboard. It also provides a Tcl application programming interface, which lets you automate tests by writing scripts. The jammer is available in three lane versions: x1, x4, and x8.

Base price: $27,500. *Agilent Technologies, www.agilent.com/find/pciejammer.*

operators, device developers, and standards organizations pushing the introduction of LTE as the next-generation mobile broadband networks," concluded Phil Medd, product manager for the Aeroflex 7100 LTE handset tester. www.aeroflex.com.

Multitest sells MEMS test module for magnetic resistance applications

Multitest announced it has recently received an order from an international IDM for a MEMS module for a magnetic-resistance applications in the automotive industry. The decision was driven by efforts to bring down the cost of test, Multitest said.

The module will run in conjunction with the MT99xx, Multitest's kitable high-speed gravity handler, which is octal-site qualified. In addition, an OCR (optical character recognition) reader integrated in the contact cassette of the MT99xx will enable the customer to correlate the test results with various test settings. The customer also will be able to convert its MT99xx to accommodate different MEMS package styles. www.multitest.com.

CALENDAR

SAE World Congress, April 20–23, Detroit, MI. *SAE. www.sae.org.*

International Reliability Physics Symposium (IRPS), April 26–30, Montreal, QC, Canada. *IEEE Reliability Society. www.irps.org.*

ESTECH, May 4–7, Schaumburg, IL. *Institute of Environmental Sciences and Technology. www.iest.org/estech/estech.htm.*

International Microwave Symposium, June 7–12, Boston, MA. *IEEE Microwave Theory and Techniques Society. www.ims2009.org.*

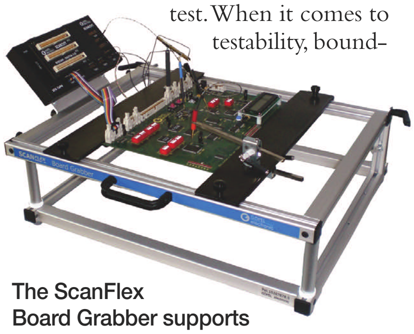
To learn about other conferences, courses, and calls for papers, visit www.tmworld.com/events.

RICK NELSON
EDITOR IN CHIEF
rnelson@tmworld.com

Board test evolves, APEX panel to elaborate

As electronic products become more complex, engineers increasingly need to build in testability at all levels—chip, board, and system—and the testability they provide should address complete product and component life cycles, ranging from silicon debug to end-product field service.

Technologies that can serve to ensure the quality of boards and systems range from x-ray and optical inspection through functional board and system test. When it comes to testability, boundary-scan techniques play a significant role, and vendors are focusing on expanding their boundary-scan-related offerings. We covered the topic in our February issue ("Moving beyond IEEE 1149.1," www.tmworld.com/2009_02), and since that article went to press, Goepel electronic has introduced a series of universal board fixtures (**figure**) compatible with its ScanFlex boundary-scan hardware platform, and JTAG Technologies has released new versions of its JTAG ProVision and Visualizer development and hardware debug tools, which now offer features such as an interactive cluster test generator, buffer and multiplexer support for memory testing, expanded model libraries, and an enhanced user interface that, for example, presents board views in multiple orientations.



The ScanFlex Board Grabber supports laboratory verification and prototype programming; it can also serve in repair-station applications. Courtesy of Goepel electronic.

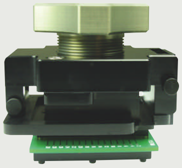
In other recent boundary-scan-related news, Glenn Woppman, president and CEO of Asset InterTech, was named a finalist for sister-publication *EDN*'s Innovator of the Year award (www.edn.com/innovation). *EDN* editors selected Woppman because of his company's work with on-chip EI (embedded instrumentation); Asset's efforts involve participation in the IEEE P1687 Internal JTAG standard working group, whose goals are to provide a nonproprietary standard for access and control of EI, regardless of the source of the IP.

Of course, inspection, in-circuit board test, and functional test will continue to play a role. Currently, the inspection business might be in the most fluid condition, because key participant Agilent Technologies announced on February 9 that it is exiting the automated x-ray and automated optical inspection businesses. Jack Rozwat, Americas sales and support GM for the systems and solutions team in Agilent's electronic measurements group, said the company wants to refocus its efforts on the ICT (in-circuit test) business. Recent innovations in that area include Cover-Extend technology, which *Test & Measurement World* editors chose as a finalist for this year's Best in Test awards.

But inspection will continue to have a role to play, a role that you can learn more about at the "Test and Inspection Summit," a panel discussion that I will moderate. It's slated for Wednesday, April 1, 1:30 pm to 3:30 pm at the IPC APEX (www.ipcapexexpo.org) in Las Vegas.

Panelists will include Rozwat as well as David Buhrkuhl, president, SPEA America; Peter van den Eijnden, president, JTAG Technologies; Mark Harding, director of sales, North America, Digitaltest; Carsten Salewski, president and CEO, Viscom; and Phil Vere, managing director, Bondtest, Dage Precision Industries. T&MW

8-GHz BGA socket



Ironwood Electronics' CG-BGA-4002 socket for 1-mm-pitch 676-pin BGAs handles a 27x27-mm package size and operates at bandwidths to 8 GHz with less than 1 dB of insertion loss. The sockets dissipate several watts without extra heat sinking and can handle 100 W with a custom heat sink. Contact resistance is typically 20 mΩ per pin. Temperature range is –40°C to +100°C. Pin self inductance is 0.11 nH; mutual inductance is 0.028 nH. Capacitance to ground is 0.028 pF. Current capacity is 5 A per pin. www.ironwoodelectronics.com.

Sunplus adopts LTX-Credence Diamond

LTX-Credence has announced that Sunplus Technology has deployed an LTX-Credence Diamond platform to test its SOCs for DVD players and other mixed-signal consumer applications. Thomas Yeh, test engineering manager at Sunplus, said the company chose Diamond because it delivers the "right cost-of-test metrics for our product portfolio" and because of the application development and support services provided by LTX-Credence partner Spirox. www.ltx-credence.com; www.spirox.com; www.sunplus.com.

Verigy announces lawsuit settlement

Verigy and Silicon Test Systems have announced that a lawsuit filed by Verigy has been resolved to the parties' mutual satisfaction. As part of the confidential settlement, all intellectual property owned, developed by, or assigned to Silicon Test Systems and other parties named in the suit since June 1, 2006, has been transferred to Verigy. www.verigy.com.

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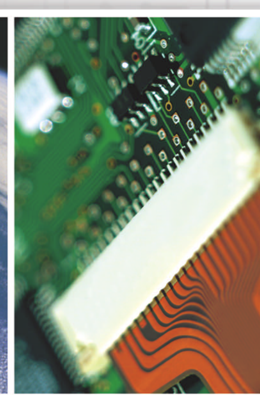

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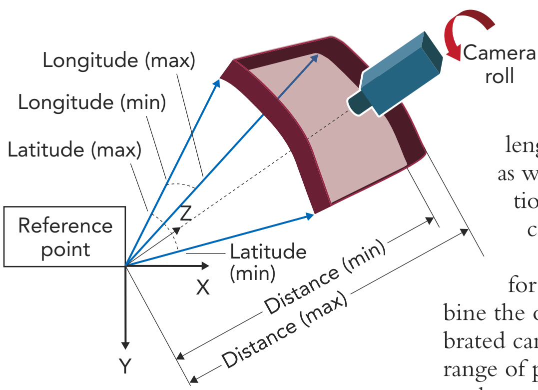
LARRY MALONEY
CONTRIBUTING TECHNICAL EDITOR
larrymaloney@verizon.net

3-D vision made simple

Most machine-vision applications require only a 2-D solution, but 3-D applications have been increasing over the last five years as manufacturers add more automation to their production lines.

"One of the biggest drivers for 3-D is the move toward greater use of robotics," said Heiko Eisele, president of MVTec, a Munich-based machine-vision software company with US offices in Cambridge, MA. "While companies need the increased throughput that robots deliver, they also need a human's ability to recognize a greater variety of objects in three dimensions, and that means integrating a vision system with the robot application."



In training a single-camera 3-D vision system, users combine a calibrated camera with an object model to determine a specified range of poses that a part will present to the camera.

This may sound like an expensive proposition, but it doesn't have to be. Traditionally, such 3-D applications require two cameras, which use a triangulation technique to acquire 3-D image data. But with advancements in software algorithms and precise camera calibration, you can achieve 3-D vision with just one camera, noted Eisele. "All you need is a standard machine-vision camera, an illumination source, a host PC, and application software," he said.

Take the example of an application that calls for a robot to pick a part from a bin and feed it to the next station on a production line. As Eisele explained, you must first determine which parts are suitable for grasping by the robot and then decide the appropriate grasping points. To accomplish that step, MVTec's customers use the company's Halcon application software to import a 3-D CAD file of the part, from which it creates an "object model" of the part.

Along with creating the object model, users also must calibrate the camera. Many calibration procedures only compute the size equivalent of a pixel or interpolate between known grid points. But that approach isn't sufficient for 3-D vision, said Eisele. You must include the intrinsic camera parameters in the calibration, such as the focal length and distortion coefficients, as well as the position and orientation of the camera in a world coordinate system.

During the training process for the vision system, users combine the object model with the calibrated camera to determine a specified range of poses that the part will present to the camera in six degrees of freedom. "This is what we call the 3-D matching process," explained Eisele. "You basically are creating one contour-based model for each possible camera pose, but the software does it automatically for you, including the camera calibration step. We've simplified the process so users can focus on the parameters of the application."

MVTec is approaching robot OEMs and system integrators with this single-camera 3-D vision concept. Among the many possible applications: guiding robots for welding and sealing operations. Eisele pointed out, however, that the single-camera technique is not suitable for measurement tasks, such as determining the thickness of solder on a part. "This requires a two-camera solution," explained Eisele, "because you are not working with a known object. You can't measure and determine position at the same time with one camera." T&MW

Four-in-one frame grabber cuts costs

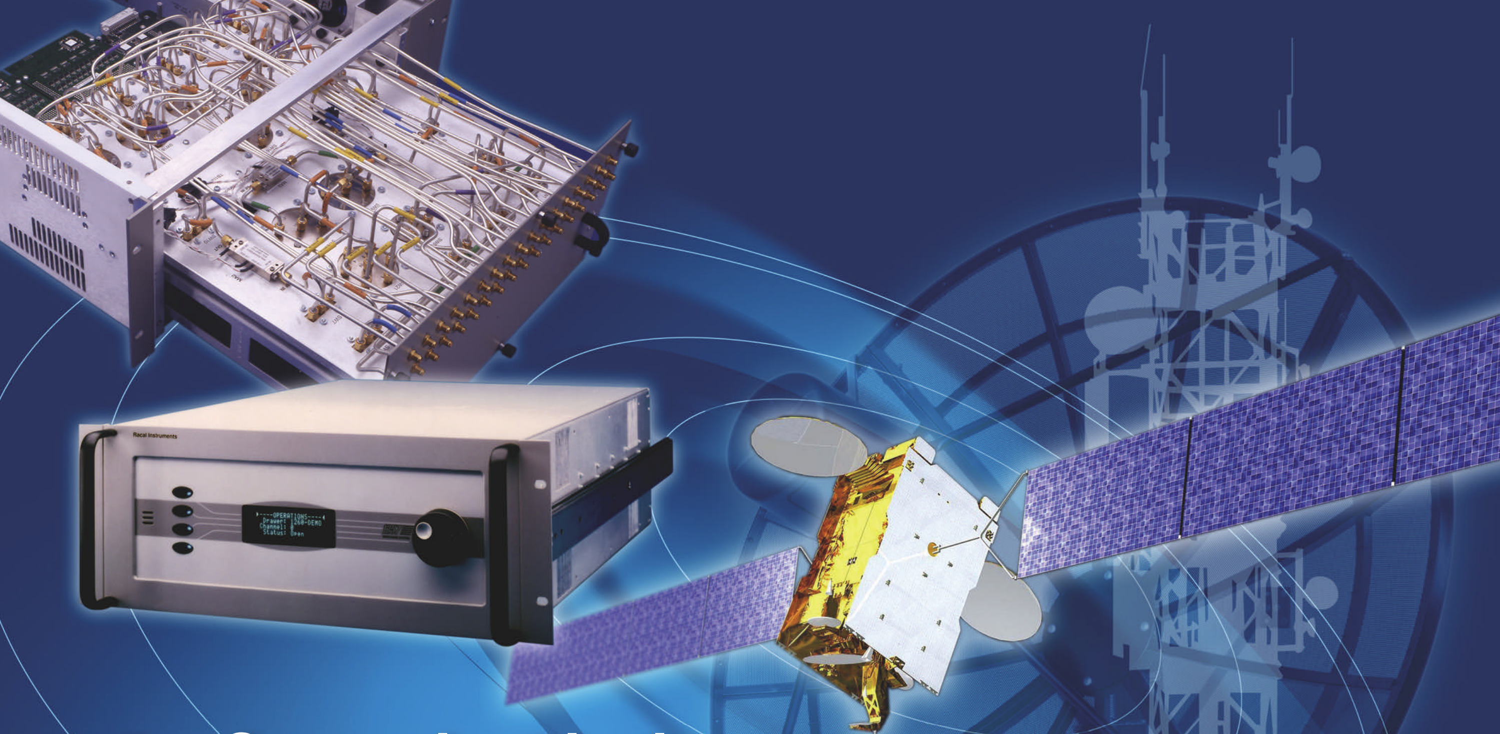
BitFlow's Karbon-CL is reportedly the first PCI Express frame grabber that can simultaneously acquire images from up to four Camera Link cameras. The frame grabber provides zero latency access to data, zero CPU usage, and unlimited DMA (direct-memory access) destination size. In applications requiring extremely high data rates, the Karbon-CL can handle up to 160 bits at 85 MHz. www.bitflow.com.

Compact LED boasts greater output

With a form factor comparable to fiber optics, StockerYale's Cobra Slim LED module offers 10 times the output power of the existing Cobra illuminator. Targeted for line-scan inspection applications, the illuminator's performance rivals that of fluorescents, halogen, and metal halide. The modular LED can provide broad angles of light radiation or homogeneous lighting. www.stockeryale.com.

Quality standards for Data Matrix codes

To help manufacturers who want to employ DPM (direct part marking) for applications such as tracking PCB serial numbers during manufacturing, Cognex has released a white paper that describes the best part-marking methods for a variety of applications. "New Standards Reliably Verify 2D Data Matrix Codes" also gives an overview of the latest standards for DPM, including new metrics for ensuring 2-D Data Matrix quality. www.cognex.com.



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40-Gbps and 100-Gbps Ethernet coming into focus

Today's 10-Gbps optical and electrical links are running out of steam. To address the problem, engineers are working on IEEE P802.3ba, a standard that will define an architecture for 40-Gbps and 100-Gbps Ethernet (Ref. 1).

Although IEEE P802.3ba is still in the works, engineers around the world are beginning to develop products for the high-speed links, and those products will need testing. While much of the testing for IEEE P802.3ba will leverage 10-Gbps technology, some tests will require new equipment and techniques.

IEEE P802.3ba defines an architecture that can support 40-Gbps and 100-Gbps transmission over single-mode and multimode fibers. The key to the architecture is its flexibility. It uses multiple lanes to carry signals on a single fiber or multiple fibers over several specified distances (**table**). The standard also defines an architecture that supports copper connections over cables and backplanes.

Both 40-Gbps and 100-Gbps implementations can use existing 10-Gbps fiber PHYs (physical links). In the future, the same architecture will support 100-Gbps links using four 25-Gbps lanes.

For 40-Gbps links, the IEEE P802.3ba protocol sublayers create four 10-Gbps lanes, while for 100 Gbps, the standard defines sublayers for ten 10-Gbps lanes. Because these implementations will use 10-Gbps lanes, you can use existing optical test equipment such as oscilloscopes, spectrum analyzers, power meters, and BER (bit-error rate) testers to test individual lanes.

IEEE P802.3ba also defines 100-Gbps transmission using four 25-Gbps lanes, but those implementations will take a few more years to develop. When they do, test equipment will need to support those data rates. In fact, some new equipment has already begun to appear.

FIGURE 1. Ixia used its 100 GE Development Accelerator System to demonstrate a 100-Gbps data link. Courtesy of Ixia.

Transmission distances for physical media

Minimum distance	40-Gbps Ethernet	100-Gbps Ethernet
1 m over backplane	40GBASE-KR4	
10 m over copper cable	40GBASE-CR4	100GBASE-CR10
100 m over OM3 multimode fiber	40GBASE-SR4	100GBASE-SR10
10 km over single-mode fiber	40GBASE-LR4	100GBASE-LR4
40 km over single-mode fiber		100GBASE-ER4

Ixia has used its 100 GE Development Accelerator System (**Figure 1**) together with equipment from Avago Technologies and Infinera to prove that multilane, 100-Gbps optical transmission is possible (Ref. 2). The demonstration, which took place in June 2008 in Las Vegas, used the Ixia system to generate 100 Gbps of Ethernet traffic.

Earlier this year, Anritsu introduced cards for its MP1800A signal analyzer that can generate modulated signals at rates up to 28 Gbps. That's enough to test future implementations of 100-Gbps Ethernet running on four 25-Gbps lanes.

What's still needed?

Although existing 10-Gbps Ethernet test equipment will get things started, IEEE P802.3ba will likely give rise to new test equipment. For example, a four-lane or 10-lane BER tester will reduce test time over using a single-channel instrument.

Protocol analyzers that decode the 66-bit data blocks into Ethernet packets will also help. In addition, testers that inject unexpected alignment blocks and remove expected alignment blocks will help you test your network link under stressed conditions.

The 25-Gbps data rate will require manufacturers to develop electrical and optical components capable of reaching that speed, and test equipment will need to keep up. For example, real-time oscilloscopes will need even more bandwidth than the current 30-GHz state-of-the-art.

You'll also need BER testers, clock-recovery units, optical spectrum analyzers, and other equipment capable of working with signals at those speeds and with multiple lanes of traffic. Stressed-eye testers will let you test optical receivers for the added signal distortion that will occur at the higher bit rate.

To learn more about 40-Gbps and 100-Gbps testing, download the article "40-Gbps and 100-Gbps Ethernet will bring new test challenges" from the online version of this article (www.tmworld.com/2009_03). There, you'll find diagrams of the IEEE P802.3ba sublayer architecture and links to several relevant technical papers. In addition, engineers from Agilent Technologies, Anritsu, Force10 Networks, Spirent Communications, and the University of New Hampshire Interoperability Lab share their insights on this emerging technology.

Martin Rowe, Senior Technical Editor

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Bias current modulation eliminates wiring errors

By modulating the excitation current applied to a temperature-sensing diode, you can eliminate errors caused by voltage drops along sensor wires.

By W. Stephen Woodward, Consultant, Chapel Hill, NC

Diodes make good temperature sensors because they are inexpensive, robust, stable, and sensitive, and they don't need reference junctions. Diodes require an excitation current to produce a PN-junction voltage, which varies with temperature by –2 mV/°C. The excitation current causes voltage drops in measurement wires because of a wire's resistance. You need to compensate for those voltage drops so that the measurement will accurately represent the diode voltage.

Many circuits remove the excitation current from the measurement using a four-wire Kelvin connection: Two wires carry the excitation current, while the other two wires connect the sensor to an ADC (analog-to-digital converter) or measurement instrument. But by using a modulated excitation current, you can use just two wires and still remove the losses in the wires.

The circuit in **Figure 1** cancels the wiring-resistance error while needing only two conductors in the sensor cable. It relies on the fact that voltage drop in the wires is directly proportional to current (i.e., Ohm's Law), but the sensor voltage is mostly constant. If you measure the total voltage drop across the wires and sensor at two current levels, you can remove the error. The circuit alternates the magnitude of the excitation current (I_b) between two values, I_{b1} and I_{b2}, where $I_{b1} = 2I_{b2}$. The AC component of the resulting signal is thus (approximately) I_bR_w where $R_w = R_{w1} + R_{w2}$ plus a minor contribution from nonzero sensor impedance.

The internal oscillator of the LTC1043, set to ~500 Hz by connecting the external 0.01-µF capacitor to pin 16, becomes the clock for both I_{b1} and I_{b2} excitation modulation and synchronous demodulation of the resulting response. The resulting toggling of the excitation ballast resistance between 1 MΩ and 2 MΩ (1 MΩ + 1 MΩ) creates the 2:1 current modulation and an AC signal component proportional to wiring resistance R_w, which is I_bR_w.

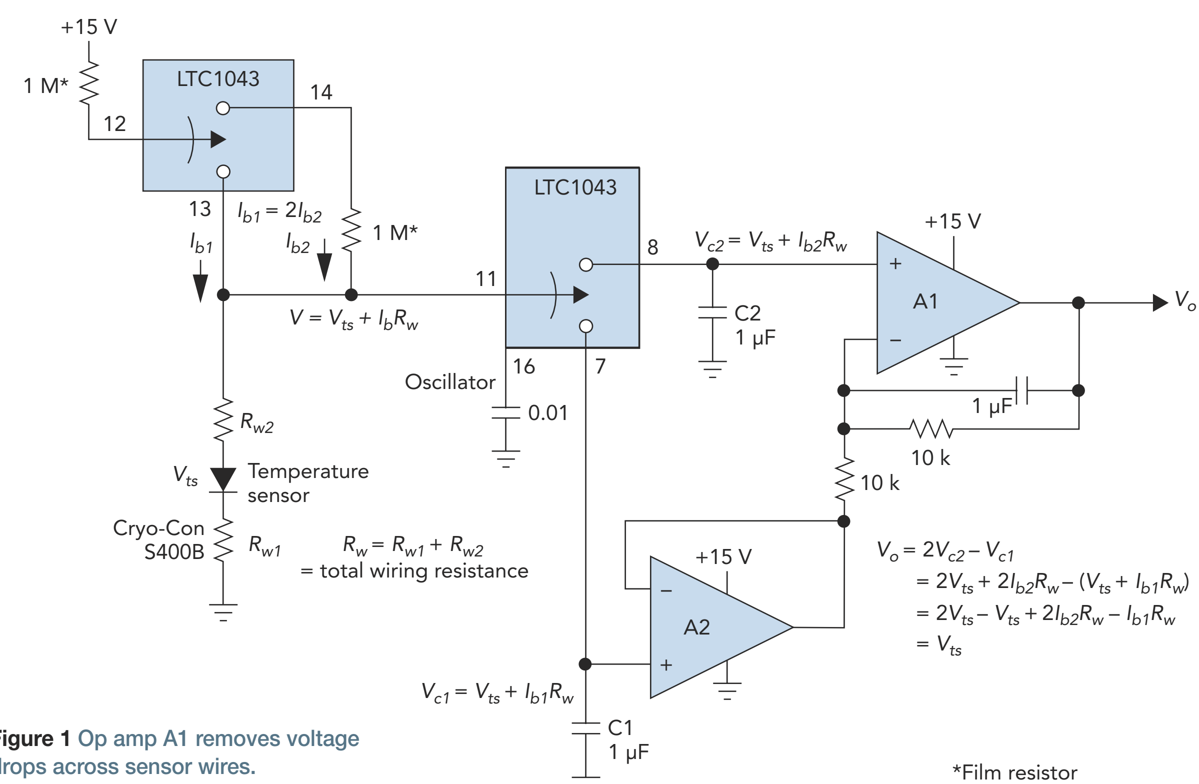

Figure 1 Op amp A1 removes voltage drops across sensor wires.

The other side of the LTC1043 switch, with the $I_{b1}R_w = V_{c1}$ phase stored on C1 and the $I_{b2}R_w = V_{c2}$ phase on C2, synchronously rectifies the I_bR_w AC component. Op amp A2 buffers V_{c1} from the resistor network where amplifier A1 subtracts it from the average sensor signal. The circuit's output voltage is thus independent of error voltages in any cables.

One downside of the technique is that, due to nonzero sensor-impedance effects (on the order of 20 mV), you need to calibrate the sensor for accurate operation with this new circuit. You can calibrate the sensor in a variety of ways depending on the temperature span and precision requirements of your application. For example, you can perform a one-point calibration using a convenient temperature reference such as the boiling point of liquid nitrogen (77 K, –320.5°F, and –195.8°C). T&MW

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The Art of Wireless

TESTING ENSURES MUSEUM VISITORS ENJOY A RICH MULTIMEDIA EXPERIENCE.

BY RICK NELSON, EDITOR IN CHIEF

Los Angeles, CA—A new wireless LAN system installed at the Los Angeles County Museum of Art (LACMA) enhances visitors' experiences while supporting museum staff. Currently, the system delivers multimedia content to visitors equipped with museum-issued PDAs (personal digital assistants), it provides museum staff members with wireless connectivity to the museum's wired network, and it serves as a WiFi hotspot to visitors who bring their own laptops to the museum campus.

Ultimately, the system may support wireless ticket and member-card scanners, enable VoIP communications among museum staff members equipped with mobile handsets, and provide RFID capability for controlling the museum collection, which numbers more than 100,000 objects.

The current and envisioned uses of the wireless-LAN capability entail various types of data traffic with widely varying quality-of-service requirements for factors such as allocated data rate, total bandwidth, jitter, and latency. And because the museum's wireless LAN connects visitors and staff while providing connectivity to the museum's wired network, security is a concern as well. Before choosing and

Peter Bodell, CIO, oversaw prequalification testing before deploying a wireless LAN at the Los Angeles County Museum of Art.

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Table 1. Initial estimates of device traffic

User devices	Number of devices per AP	Data rate allocated per device (Mbps)	Total bandwidth consumption per AP for all devices (Mbps)	Total bandwidth consumption for six APs (Mbps)
Guest PDAs	60	0.2	12	72
Employee laptops	3	1	3	18
Scanners	3	0.128	0.384	2.304
VoIP clients	3	0.15	0.45	2.7
Guest laptops	10	0.256	2.56	15.36

installing its wireless LAN, LACMA performed extensive testing to ensure security while being able to provide the traffic-handling capability necessary to provide a positive user experience to museum visitors and staff members.

Why wireless?

The impetus to install a campus-wide wireless network occurred in 2003 when LACMA undertook to build the Broad Contemporary Art Museum within its campus. "We had been looking at wireless technology for several years, but it wasn't really mature enough for us in this particular environment," said Peter Bodell, LACMA's CIO, during an interview at the museum campus in January. "We had implemented some wireless capability in some areas, but it wasn't necessarily viewed as a campus-wide project. But when the museum said, 'yes, we are going ahead with the Broad building,' it was the ideal opportunity to build out a campus-wide wireless system that would connect to our existing infrastructure."

Bodell noted that, "Traditionally, museums have audio tours and paper-based content, so we stepped up and said, 'alright, we need to go to the next level—we need to get it to multimedia.' So, we investigated a grant opportunity with the Irvine Foundation, which we were successful in securing. The grant provided funds for us to deploy PDAs within the museum and to develop content for them. In concert with that, we looked at wireless systems from a standpoint of, 'OK, what's best for us at the moment, and what can we foresee in the future?'"

With an estimate of current and future needs, the museum developed an outline of expected deployed devices and traffic patterns (**Table 1**) and enlisted consultants to determine which of two competing vendors of wireless LAN implementations could best meet the museum's requirements. Explained Bodell, "We started out with a floor plan for the various floors and galleries, and we estimated we could have a capacity of up to 300 visitors in a gallery. So, I looked at worst-case scenarios: If I have 300 people in this space, how do I need to lay out my access points to provide continuous coverage?"

LACMA's unique approach

A unique approach taken by LACMA was that Bodell recognized that the expected mix and match of traffic would influence whether a particular wireless LAN vendor's installation would meet expectations. "What we typically see is a lot of end users who say, 'Just make sure I can connect 10 clients and they can each do an FTP session,' or something like that," said Eran Karoly, VP of marketing at VeriWave, which provided the traffic-generation and -analysis equipment and software suite used to evaluate competing wireless LAN systems that the museum considered.

"Many end users," said Karoly, "don't recognize that different uses require different quality of service. But LACMA recognized that in every hall or building there's a variety of sessions that are going on, and there are a variety of users, with each having different requirements. The user who's using a VoIP session requires very low delay, very low latency, and very low jitter, while somebody who is retrieving e-mail is not too sensitive to those things. What we got from LACMA was a blueprint that said, 'this is the amount of users of type *a* and type *b* and so forth, and all of them need to be served simultaneously.' And we were told, 'OK, now create and analyze that mix of traffic.'"

To do that, VeriWave established a test bed (**Figure 1**) consisting of the following components:

- a wireless LAN controller (supplied by the participating vendors);
- six IEEE 802.11a/b/g APs (access points; supplied by the participating vendors);
- a VeriWave WaveTest 90 traffic generator/analyzer, equipped with six 802.11a/b/g test interfaces and one Gigabit Ethernet test interface;
- a Hewlett-Packard ProCurve 3500yl L2/L3 Gigabit Ethernet/PoE (power over Ethernet) switch;
- a Windows 2003 server; and
- assorted coaxial cables, SMA connectors, attenuators, and line splitters.

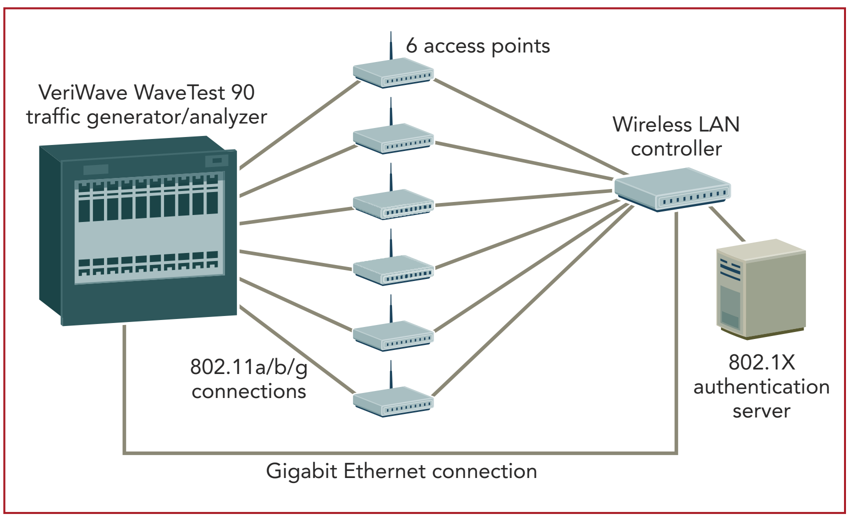

FIGURE 1. The LACMA test bed consisted of a VeriWave WaveTest 90 traffic generator and analyzer, an authentication server, and a wireless LAN controller and six access points provided by participating vendors.

Jane Burrell, VP for education and public programs, said LACMA's wireless LAN and PDAs present a great opportunity for curators and educators: "With the ability to show images, we can tell a different kind of story—one that we couldn't tell with a label."

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With its six APs, the tester modeled the hundreds of APs that would be mounted throughout the various art galleries, hallways, public areas, and office spaces. To ensure that the test measured traffic conditions only—and not RF variability or multipath effects—the APs were directly cabled to the VeriWave test interfaces.

The evaluation involved these tests:

- a load test, using VeriWave's WiMix test suite, which blends planned data and voice applications originating from the independent clients communicating with each AP;
- a client capacity test, which uses the WiMix suite with various numbers of clients to determine the maximum number of concurrent clients each AP can support;
- a guest PDA goodput test, which creates high packet rates from independent PDA clients communicating with each AP; and
- an employee Web traffic goodput test, which models high bandwidth consumption from independent employee laptops and other clients communicating with each AP.

The controlled testing, said Karoly, enabled LACMA to move beyond vendors' often oversimplified claims that a given facility will need *x* number of APs to cover *y* square feet. And in fact, the tests showed that although LACMA's initial plan called for each AP to support up to 79 user devices, neither of the two systems under consideration could meet that goal. Given LACMA's defined traffic, one vendor could support a maximum of 30 user devices per AP, while the other could support a maximum of 25 user devices per AP.

"LACMA came up with a traffic profile it expected every AP to handle, and one of the conclusions of the test was that the goal was overly optimistic, resulting in a more realistic and more dense AP deployment," said Karoly. VeriWave has published a case study (Ref. 1) that provides a complete summary of the test results. Karoly noted that VeriWave, 80% of whose business is with equipment suppliers while 20% is with carriers, service providers, and IT departments like Bodell's, doesn't make vendor recommendations based on test results, leaving that task to independent consultants or the IT departments themselves.

Bodell did not disclose the name of the vendor ultimately chosen as a result of the test, and in fact, different traffic patterns at different installations may have resulted in a different choice. He did say that the testing was critical to making the right choice.

"The chaps at VeriWave came in and, in essence, set up their systems to emulate the traffic that we expected to see in the galleries," said Bodell. "And that helped enormously in making a decision. VeriWave helped to recommend how to lay out the access points in the spaces so we could connect people to the system, track them, and provide them with continuous coverage. It was really a matter of saying, 'OK, what's the ideal number of sessions you could have attached to any particular access point as users move from access point to access point within the space? How is the handoff going to take place? Will this type of access point work in this environment?'"

Bodell explained that the testing enabled LACMA to make the right decision before engaging in a substantial capital investment and complex installation process while controlling support costs. And in fact, he said, the technology can help reduce costs, because an effective entrance control system, perhaps based on RFID technology, could reduce the number of guards required.

That's in keeping with a key museum goal. Said Bodell, "The museum has always been supportive of technologies that provide a way to leverage operational costs." Moreover, he said, technology is increasingly important in the museum environment: "Over the past five to seven years, there really wasn't a lot of interest in technology in the galleries. You think of a typical art museum with art on the walls and sculptures, but the concept of actually having technology in a gallery was somewhat new. It's only recently where we started to see, because we have a lot of interest in contemporary art, that a lot of modern artists are starting to work with technology as a medium. So now all of a sudden, you've got technology pieces in a gallery, and you've got to be able to support that with power and network connectivity and access to the Internet."

He said that going forward, PoE might complement wireless connectivity already installed to support technology works. "It's very bleeding edge for a museum," he said, "but at the same time, it's an area that I'm watching."

Town squares and virtual galleries

The wireless capabilities extend beyond the galleries, Bodell said, in support of the museum's effort to create an environment that loosely mimics the feel of a town square, "where people can come mostly to enjoy the art but also to socialize and to sit down with a laptop and get a bite to eat. We want to create that environment where people can coexist and communicate, and the concept is one that we are very excited about."

During the LACMA wireless LAN prequalification testing, the VeriWave WaveTest 90 and WiMix test suite provided load and client capacity tests.
Courtesy of VeriWave.

But the wireless capabilities will be best taken advantage of not by the museum's restaurant customers with laptops but by visitors who check out a PDA—a Nokia tablet PC that Bodell selected for its long battery life and large screen. As visitors stroll about the museum, they can key in three-digit codes discretely presented near each object that has associated multimedia content. Visitors can listen to audio content while examining similar works on the Nokia tablet's screen, and they can drill down to learn more about the artist, the subject matter, the period when the work was created, and so on. As visitors tour the museum, they can select certain works as their "favorites." By the time they get home, the museum has e-mailed them a link to their own personal "virtual galleries," where they can review their favorites and do more research.

Bodell elaborated on how the system works: "When you check out a PDA, we ask you for an e-mail address and set up an account for you. As you walk around, the device is known to the system by its MAC address, which is in turn tied to your e-mail address, so that device and everything you do on that device is tied uniquely to you. You can save preferences as you walk around, and those preferences are transmitted over the wireless system to a back-end database that has relationships with the objects that you've selected. When you return the device, the system closes out your connection and automatically sends you a couple of e-mails that say thanks for coming to LACMA and this is what you need to do to access your virtual gallery. All the objects you saved as preferences are there displayed for you, and you can move them around and create your own galleries.

"The goal," he continued, "is to give you access to more content that's connected to LACMA's collections management system, which has a lot more information about the objects. We plan to use that as a vehicle for CRM [customer relationship management] personalization, because we really feel that in the future—instead of having Websites that have a shotgun approach—we need to personalize the experiences for our visitors."

Telling a different kind of story

Technical considerations make up only part of the challenges as the museum implements its wireless LAN system. Content creation is another challenge.

Speaking of the wireless LAN system, Jane Burrell, VP for education and public programs, said, "It's a great opportunity for us. One of the things we hear from our curators all the time is, 'We want to write more—there is so much more we want to say about our objects.' But there is only so much that people can read in the galleries. We have strict guidelines for how much written text we can have in the galleries, and visitors can only absorb so much. But with the ability to show images, we can tell a different kind of story—one that we couldn't tell with a label."

Furthermore, she added, "With the back end that Peter implemented, visitors can go back home and revisit what they saw in a virtual gallery, and in fact, they can take advantage of the whole multimedia experience without ever coming here. It's given us many more ways to connect with the visitors and give them a fuller picture of an object."

As for user reaction, Bodell said it's too early to tell, noting that the museum hadn't aggressively publicized the system pending rollout of more multimedia content, which was just becoming available during my January visit. But Burrell said initial indications are that "People love the content—

Annie Carone, who works in LACMA's public relations department, uses a wireless PDA to learn more about objects in the museum's collection. By the time she gets home, the museum will have e-mailed her information about objects that she tagged as favorites.

STEVE LABADESSA

they've really been excited." And Bodell added that people equipped with the PDAs spend exponentially longer times in the galleries. The museum is undertaking a formal evaluation of the system in pursuit of an additional grant that would provide funding to create more content.

As for how content gets created, Burrell said, "Curators will work with educators to pick objects and provide some idea of what direction they want the content to take. The educators decide what assets are available—what visuals could help tell the story, and what other stories could be told. Then, we prepare a very detailed outline and send it off to a freelance writer whom we also direct to different Websites for additional information. The writer prepares a rough draft of a script, and then the educators review that. The script gets refined through a back-and-forth process, until the curators and the educators are satisfied with the final script. As we are doing that, we simultaneously are clearing the rights for the assets that the educators or curators have identified. It's a very collaborative process."

Burrell used Kurt Schwitters' "Construction for Noble Ladies" to provide an example of the types of information a multimedia treatment can provide: "The Schwitters is a painting where he used a lot of found objects to create what he wanted you to come away with. Most visitors look at that painting and don't really see all the details that are in that work of art. But when you look at that painting on the PDA or computer screen, you can use what we call 'touch and listen' to highlight the different found objects and bring up another screen that tells you what that object is and why he chose it."

Content creation and rights management are proving to pose as difficult challenges as the wireless LAN installation. Burrell said that clearing the rights to use videos has been the most difficult. She explained, "We've had so many people turn us down for video—just small documentary filmmakers who thought, 'OK, this is my chance to get rich.' We only have limited funding for the rights, so we've had to say, 'we just can't afford it.' You would think the exposure for some documentary with limited distribution would be great, but they really saw this as their opportunity to make money."

Alternatively, she said, some institutions simply aren't set up to address the rights issue. "They just ignore our requests; our phone calls don't get returned."

As content creation continues, Bodell is looking to the future of wireless technology. He said, "What the museum is planning to do in later phases of the transformation triggered by the Broad building construction is move more toward a very flexible work environment for the staff. What I'm really looking for is a solution that implements fixed-mobile convergence, so you could have a piece of technology on your desk that may look like a phone, but in essence, it's a phone plus a data device. You can pick it up and walk around with it, and it's your in-house phone, your cellphone, your PDA. The museum doesn't want a fixed office environment for its staff. We want to leverage opportunities for telecommuting. The concept is to use a wired-wireless infrastructure to be able to support that."

Ultimately, Bodell wants to enable visitors to access the museum's multimedia content using their own mobile devices. "As part of the [Irvine Foundation] grant, we used an off-the-shelf piece of technology—the Nokia tablet. It's a great wireless device—you connect it to the network, and it hangs onto the connection really well, but ultimately, the goal over the next year or two is to let you use your own piece of technology." T&MW

REFERENCE

1. "Los Angeles County Museum of Art Case Study—Pre-Qualifying a Wireless Campus Network," VeriWave, 2008. www.veriwave.com/gurus/case_studies.asp.

TESTING WiMedia UWB

The bandwidths and frequency-hopping behavior of ultrawideband devices impose stringent test challenges—extending from the development of software used in bench instrumentation to the layout of device interface boards used in production.

BY MIKE CARR, TERADYNE

WiMedia UWB (ultrawideband) constitutes a short-range wireless link that transfers data at very high rates. Employing OFDM (orthogonal frequency-domain modulation), a UWB link can transmit error-corrected data at rates between 53.3 and 480 Mbps over short distances—a capability that has already been adopted for Wireless USB and Bluetooth 3.0 applications.

The bandwidths and modulation schemes used in UWB present significant test challenges that extend from the software used to characterize UWB devices on the bench up to the layout of the DIB (device-interface board) that must route 10-GHz signals to and from a DUT (device under test) during production test. The spectrum allocated for UWB goes from 3.1 to 10.6 GHz and is divided into six frequency bands called band groups (**Figure 1**). Each band group has three sub-bands, with the exception of group 5, which has two. The OFDM symbols can hop across sub-bands in each band group, but they cannot hop between groups.

Table 1. Hop sequences for time frequency codes

TFC	Hop sequence (carrier number)					
1	1	2	3	1	2	3
2	1	3	2	1	3	2
3	1	1	2	2	3	3
4	1	1	3	3	2	2
5	1	1	1	1	1	1
6	2	2	2	2	2	2
7	3	3	3	3	3	3
8	1	2	1	2	1	2
9	1	3	1	3	1	3
10	2	3	2	3	2	3

A hopping sequence is called a TFC (time frequency code) and occurs between OFDM symbol-to-symbol transitions in a predefined order. Each band group supports 10 TFCs (**Table 1**). Note that TFCs 1 through 4 hop across all three carriers in a band group, while TFCs 5 through 7 stay on one carrier, and TFCs 8 through 10 hop between two carriers. The OFDM signal consists of 128 subcarriers spaced at 4.125-MHz intervals: 100 data-bearing subcarriers, 12 pilot subcarriers, 10 guard subcarriers, and six null subcarriers (**Figure 2**).

The data subcarriers employ two modulation schemes (**Figure 3**): QPSK

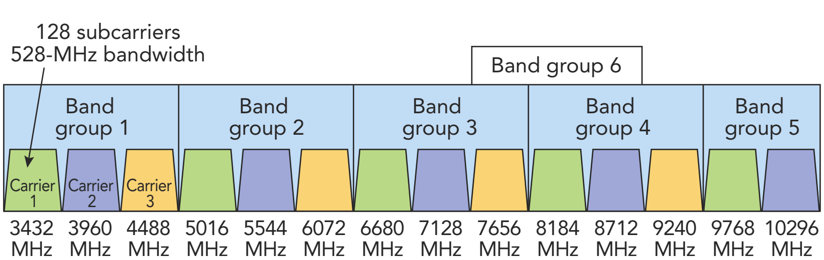

FIGURE 1. The spectrum allocation for UWB encompasses six band groups and extends from 3.1 to 10.6 GHz.

(quadrature phase-shift keying) and DCM (dual carrier modulation). The quality of the UWB link determines which scheme is used. A high-quality link will employ the more efficient DCM scheme with less error correction to maximize the data rate. A lower-quality link will revert to a less efficient, more redundant scheme employing QPSK with more error correction. This dynamic approach causes the data rate to vary between 53.3 Mbps and 480 Mbps.

In the QPSK mode, two bits are I/Q modulated on each data carrier. For each UWB symbol, the net effect is

(2 bits/data carrier) x (100 data carriers) = 200 bits/symbol.

To improve the BER (bit error rate), UWB employs two types of redundancy: TDS (time-domain spreading) and FDS (frequency-domain spreading). TDS essentially transmits the same data over two bursts. FDS transmits the same data on two carriers within the same symbol. Each of these redundancy schemes cut the raw throughput of 200 bits/symbol in half.

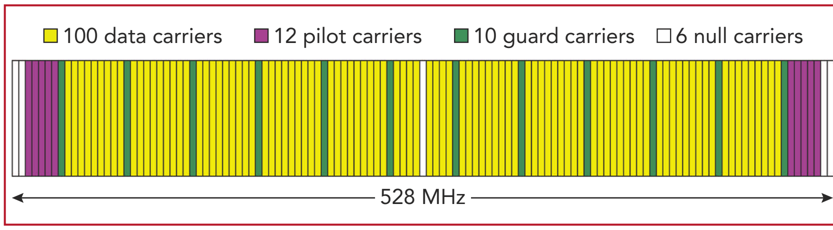

FIGURE 2. The 128 subcarriers of a UWB OFDM signal can be data carriers, pilot carriers, guard carriers, or null carriers.

The DCM mode uses a 16QAM technique to modulate four bits on two data carriers spaced 50 subcarriers apart. The net throughput of this redundancy technique is:

(4 bits/data carrier) x (50 data carriers) = 200 bits/symbol.

UWB also uses FEC (forward error correction) techniques to mitigate multipath fading effects as well as other obstacles that may affect the quality of a data transmission. **Table 2** lists the data rates achieved with different combinations of modulation schemes, redundancy schemes, and FEC rates.

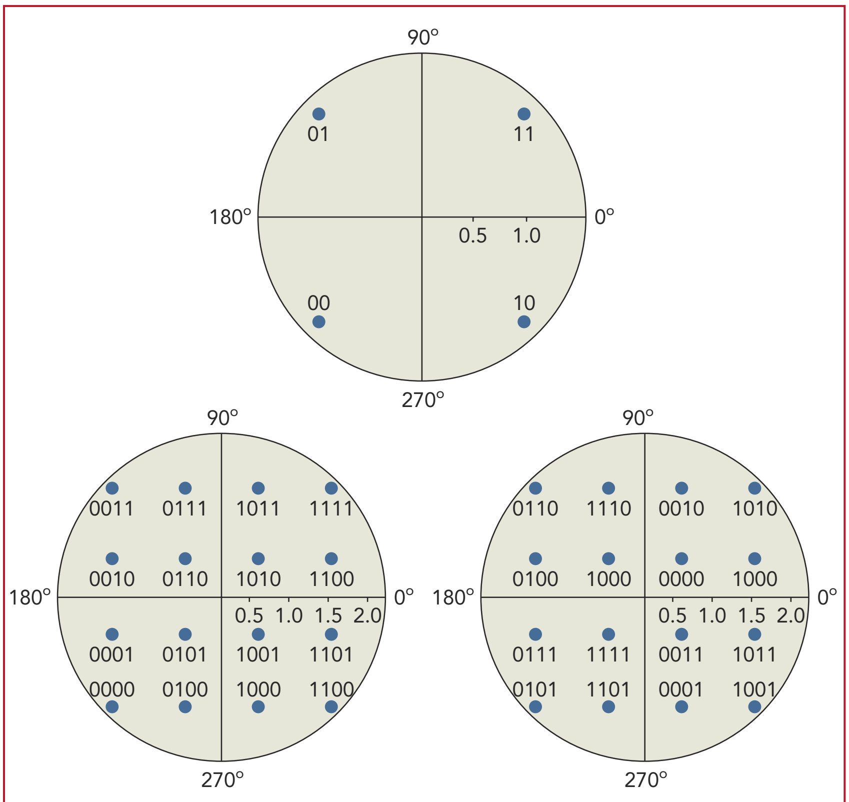

FIGURE 3. UWB modulation schemes include QPSK (top) and DCM (bottom). Link quality determines which scheme is used.

The duration of each OFDM symbol is 242.42 ns. Each symbol also has a 70.08-ns pad, so the total duration of the symbol plus pad is 312.5 ns. The following calculations show how the data rates are achieved.

To achieve the 53.3-Mbps rate, UWB makes use of QPSK as well as FDS, TDS, and the FEC rate of 1/3. The calculations for achieving this data rate are:

QPSK = (2 bits/data carrier) x (100 data carriers) = 200 bits/symbol,

FDS = (200 bits/symbol)/2 = 100 bits/symbol, and

TDS = 100 bits/symbol/2 = 50 bits/symbol.

FEC works on six-symbol intervals, so 6 symbols x 50 bits/symbol = 300 raw bits.

The FEC rate of 1/3 reduces the 300 raw bits to 100 coded bits. With symbol durations of 312.5 ns, six symbols take 1.875 µs. To transmit 100 coded bits in 1.875 µs, the coded data rate equals 53.3 Mbps.

To achieve the 480-Mbps rate, DCM is employed with no FDS and no TDS. The FEC factor is 3/4. The calculations for this rate are:

DCM = (4 bits/data carrier) x (50 data carriers) = 200 bits/symbol.

FEC works on six-symbol intervals, so 6 symbols x 200 bits/symbol = 1200 raw bits.

The FEC rate of 3/4 reduces the 1200 raw bits to 900 coded bits. To transmit 900 coded bits in 1.875 µs, the coded data rate equals 480 Mbps.

Figure 4 shows six consecutive UWB symbols. The frequency hopping takes place from symbol to symbol. The 70-ns pad occurs when the UWB device changes frequency for a hopping TFC. The settling time for a UWB hop is 9 ns.

The front end of a UWB frame consists of 24 synchronization symbols, six channel estimation symbols, and 12 header symbols. The synchronization symbols assist the receiver in timing recovery. The channel estimation symbols characterize the frequency and phase response of the transmission channel and apply that channel information to the header and payload symbols. The header has information about the payload.

Table 2. UWB data rates

Data rates (Mbps)	Modulation scheme	FEC rate	FDS	TDS	Raw data per six symbols	FEC data per six symbols
53.3	QPSK	1/3	Yes	Yes	300	100
80	QPSK	1/2	Yes	Yes	300	150
106.7	QPSK	1/3	No	Yes	600	200
160	QPSK	1/2	No	Yes	600	300
200	QPSK	5/8	No	Yes	600	375
320	DCM	1/2	No	No	1200	600
400	DCM	5/8	No	No	1200	750
480	DCM	3/4	No	No	1200	900

Transceiver details and test challenges

The challenge for UWB test engineers is to find cost-effective methods for testing UWB transceivers in as little time as possible. UWB transceivers have a basic I/Q modulator/demodulator structure. Also included is a fast switching PLL (phase-locked loop), which supplies the internal LO (local oscillator) signal that can switch at the 9-ns rate.

Some UWB transceivers may require analog baseband I/Q symbols. Other UWB transceivers may have integrated DACs (digital-to-analog converters) and ADCs (analog-to-digital converters) that require digital baseband I/Q signals. Still other UWB transceivers may be integrated with a baseband processor and require no baseband signals. These types of integrated devices may be implemented as a SIP (system in a package).

For the I/Q type UWB transceiver device, testing can be broken up into two main parts: device transmitter testing and device receiver testing. Transmitter testing typically consists of measuring EVM (error vector magnitude), channel power, spectral mask, I/Q balance, and frequency-hopping settling time. Receiver testing typically consists of measuring gain, noise figure, I/Q balance, PER (packet error rate), and BER.

The analog baseband instruments needed to test UWB transceivers require very high bandwidths. To source OFDM I/Q symbols at this rate requires at least 300 MHz of analog bandwidth. If the baseband instruments are based on DSPs (digital signal processors), the sampling rates for the I/Q sources should be greater than 1.0 Gsample/s. Similarly, baseband capture instruments should have greater than 300-MHz analog bandwidth and greater than 1-Gsample/s sampling rates.

The digital instruments needed to test I/Q transceivers with integrated DACs and ADCs also require high sampling rates. A transceiver's embedded converters can have 8-bit parallel differential I/Os; so, a device of this type would require a minimum of sixty-four 1.0-GHz digital channels for the baseband digital I/O per DUT.

For integrated UWB devices, testing is generally limited to EVM, channel power, spectral mask, and either PER or BER. Since the testing of an integrated device does not require baseband instruments, a production ATE (automated test equipment) system used for integrated UWB devices has a simpler configuration than a test system used for I/Q-based transceivers.

Testing the EVM of a UWB I/Q modulator requires a test system to source compliant UWB I/Q symbols to ensure the device is tested under the same conditions as those under which it will be used.

The hopping commands for the fast settling PLL are usually sent on a digital bus. Precise synchronization is required between the I/Q signal sources and the digital commands used to set the PLL. This synchronization is required to make sure the frequency hops of the PLL are in lock step with the I/Q symbols being sourced from the baseband instruments.

To capture the modulated RF output of a transceiver, whether SIP or I/Q-based, an RF test instrument would need better than 10 GHz of analog bandwidth. This would ensure the instrument has enough bandwidth to measure all of the band groups (3.1 to 10.6 GHz). For example, a TFC 1 signal from band-group 6 would be centered at 8.184 GHz and have a channel bandwidth of about 1.7 GHz.

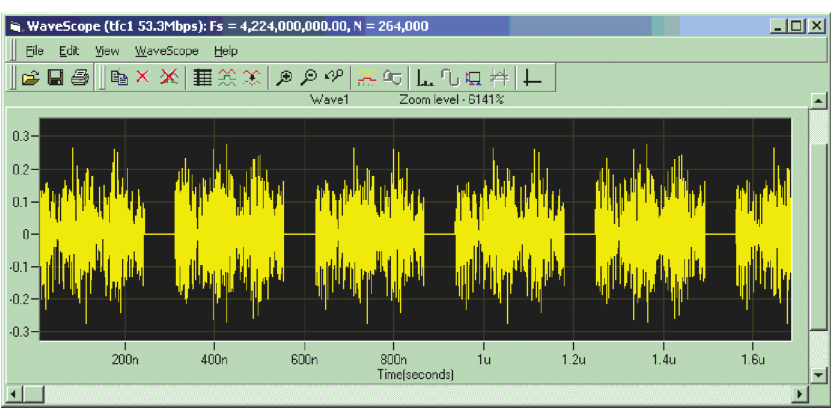

FIGURE 4. Shown here are six consecutive UWB symbols interspersed with 70-ns pads, during which frequency hopping takes place.

Using multisite test

You can dramatically reduce test time and the cost of test by testing UWB devices in a multisite test configuration that performs very fast background digital signal processing with multiple processors working in parallel on multiple sites. The tester should perform DC biasing, device setup, and RF measurements in parallel in order to achieve the fastest test time and the lowest cost of test.

To achieve the highest parallel efficiency, you should use a POP (pattern-orientated program) if possible. With a POP, the digital pattern can set up the instrumentation, send the digital commands to program the device, and initiate the RF capture. The pattern will ensure these commands are transmitted to each site at the same time. A high-speed bus and parallel DSPs will ensure the most cost-effective test time.

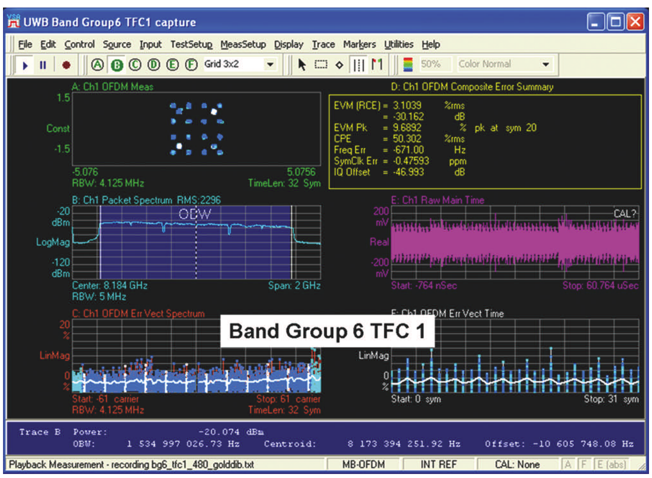

FIGURE 5. When analyzing UWB signals, using the same software from the bench instrumentation on the ATE's DSPs can speed time to market.

You could also reduce the overall test time for UWB devices by background processing the RF and baseband measurements. For example, the tester could send a captured RF signal to the DSPs, which could start computing the EVM. Then, while the tester is calculating the EVM, it could simultaneously set up the device for another test.

Developing device interface hardware

To implement multisite testing for UWB devices, you'll need to design quad-site or octal-site DIBs for UWB devices, and this is not a trivial task. The baseband analog I/Q-type UWB transceivers require precisely matched transmission lines. The test system's baseband instruments must source OFDM signals that are essentially multitones going from 4.125 MHz to 256 MHz. Differential pairs for the I and Q channels must be tightly matched. These DIB traces should be routed close to each other and should be of equal length and as short as possible. The baseband traces should be on the top layer of the DIB where the DUT is located.

The RF RX and TX DIB traces are also critical. You could design a single DIB to test UWB devices that work in different band groups. For example, you may have three different products: a band-group 1 device centered at 3.96 GHz, a band-group 3 device centered at 7.128 GHz, and a band-group 6 device centered at 8.184 GHz. If the device packages are identical and the pin-outs are the same, then you could design one DIB to test the three DUTs; just be sure that the microstrip line traces for the RX and TX can work across the full bandwidth of the device family. Keeping these traces short and picking the proper dielectric are key to designing the required wideband microstrip lines. To maintain proper signal isolation, make sure the top layer of the DIB has a flooded groundplane.

Software challenges for UWB testing

Another challenge you will face in devising a test for UWB devices is creating compliant UWB baseband and RF modulated signals as well as demodulation algorithms for measuring EVM. This is a daunting task that may require you to spend many weeks studying the WiMedia UWB standard. At the end of this time-consuming process, your math may not be 100% compliant, which will lead to miscorrelation to the bench equipment used by the designers and may delay the completion of the ATE test program.

You can shorten the time-to-market cycle if you use the compliant software from bench instrumentation on the ATE's DSPs. Using the same software will provide direct algorithmic correlation from the bench to the ATE and will let you focus on other aspects of production test. The bench software also needs the ability to operate in the DSP engines in the background of the test program execution. This feature can essentially give the ATE system bench-type qualities that make debugging and correlation much easier than before.

When employing a test procedure that combines such software with high-bandwidth instruments that have fast DSPs, you'll find it easier to keep up with emerging communication standards such as WiMedia UWB while also keeping your test costs low. Multichannel instruments will allow you to simultaneously test multiple transceivers in parallel, and fast DSPs that can work in the background will help improve throughput. Because transferring bench software to an ATE system will shorten the development time for production test, you'll get your products into production more quickly and be able to meet the market needs. T&MW

Mike Carr *is a senior RF applications engineer at Teradyne. He has more than 20 years of RF/microwave ATE experience focusing on the development of RF test techniques and production test solutions for RF transceiver devices. He received a BSEE from Wentworth Institute of Technology. mike.carr@teradyne.com.*

A microcontroller and free test tools let engineers operate the tester from anywhere.

Motion-sensor tester RUNS FROM A BROWSER

BY SEAN O'LEARY AND JED MARTI, ARTIS

Automated test stations don't always need proprietary test tools. Using a microcontroller, a PC, and free software tools, we developed an automated test station to test and align motion sensors. Test engineers can operate the system from any Web browser in the company network and can also check the status of a unit under test or retrieve data on a previously tested sensor module.

The motion-sensor module is an optical sensor that uses illuminating LEDs and focused detectors to sense moving objects. The module uses one bank of LEDs to illuminate a target and another bank of 32 detectors to sense motion. The sensor's output is a bit vector indicating the current state of each detector. The outputs of many such sensors are assembled into a profile of the moving object for identification by a pattern-matching system.

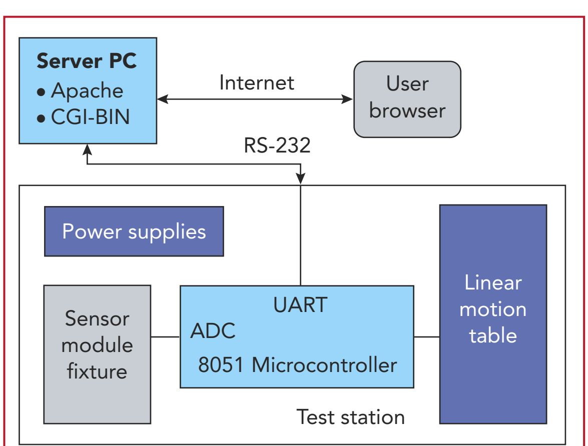

FIGURE 1. A server PC communicates to an 8051 microcontroller that operates a motion table and makes measurements.

To function properly, the sensor module's LEDs and detectors need to be mechanically aligned, something that isn't practical to do by hand. Thus, we built an automated system that provides consistent alignment and also tests each sensor's signal-conditioning and communications lines. The block diagram in **Figure 1** shows the main parts of the tester.

Using a motion table to move a sensor module in front of a known-good detector array, the test station verifies that each LED functions and is properly aligned. The system tests the 32 detectors by moving a known-good LED in front of the detector array under test. Signal-conditioning circuits in the test station boost the detector's output signal to a range detectable by an ADC (analog-to-digital converter) in the 8051 microcontroller. The ADC digitizes the signals and the station verifies the module's data transfer.

For the movable platform, we use a commercial x-axis table (**Figure 2**). A stepper motor positions the table in increments of 0.005 in. based on direction bits and clock pulses from the microcontroller.

We also designed a fixture that holds the sensor module during alignment, makes electrical connections, and provides access to the LED and detector arrays. Spring-loaded pins make the electrical connections to the sensor module. Holes in the fixture (**Figure 3**) let the sensors under test send and receive light from the LEDs and detectors as the position table moves them.

Using a Web-based system

The circuits that interface with the motor driver are located on the station's printed-circuit board (**Figure 4**), which also contains the limit sensors, the drivers for the optical devices, and the circuits for the sensor module.

The 8051 has a 10-bit ADC, 8 kbytes of RAM, 24 I/O pins, and two UARTs (universal asynchronous receiver-transmitters). An external memory chip extends the total memory to 64 kbytes. The 8051's serial port communicates between the test-system hardware and a PC running Apache Web Server under Linux. This approach has several advantages:

- The Apache Web Server software is easy to set up, secure, and free; it runs under Linux or Windows.
- Connecting the server to a serial port through a CGI-BIN (common gateway interface-binary) script is easy. A small C program on the server sends a command to the test system to start the test. The program also interprets commands and retrieves content such as bit-mapped images and HTML text. Linux C and C++ compilers are free.
- The 8051 microcontroller doesn't need to support a file system, Internet protocol, or other Web interfaces.

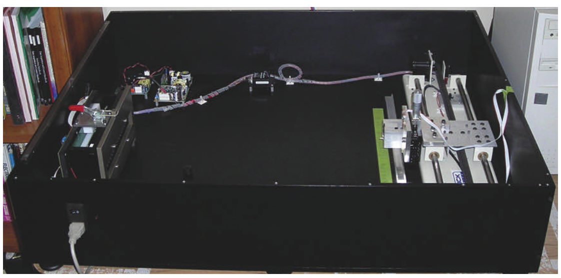

FIGURE 2. A linear motion table aligns the sensor arrays to LEDs and detectors in the test fixture.

The test system's embedded microcontroller connects to the server through a server's serial port. Test results, images, and text are stored in a data directory on the server for immediate display or recall.

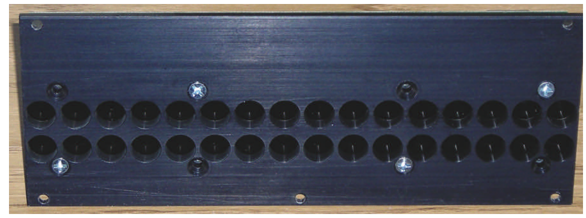

FIGURE 3. A test fixture contains holes that pass light between 32 sensors and a test board.

The server sends a command over the serial port that tells the station to execute the test. Once the server sends the start command, the station code runs through an entire test. As the microcontroller collects data, it generates tables, charts, and bit-mapped images. Once an image is completed, the microcontroller sends it to the server through the CGI-BIN program.

A simple welcome screen from the Web server tells the user when to steer the browser to the address assigned to the station. Anyone on the corporate network has access to this start-up screen. From the main Web page, a user can:

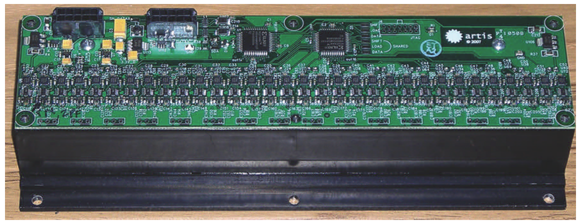

FIGURE 4. Known-good LEDs in the test fixture transmit light to a sensor module under test, and known-good detectors detect the light that the module transmits.

- see a statistics page indicating the number of devices tested and examine a summary of the results;
- view reports, by serial number, for devices whose testing has been completed; and
- initiate the test protocol.

Once testing is complete, the server displays the test results for all 32 sensors as a color graph on the Web page. This report, including all the graphs, is generated by the microcontroller and subsequently transferred to the server. This Web page contains tables and graphs detailing the results of the test as well as any messages that indicate errors or anomalies.

The Web-based system did introduce one obstacle that we had to overcome. When the user initiates the test protocol, the station opens a new Web page and begins writing to it. As tests complete, the server adds additional information to the Web page. We encountered a problem regarding dead time in communicating with the Web page. Web pages can time out in four to five minutes if they don't receive new information. Because one test took six minutes to complete, we wrote some code to ping the browser periodically to prevent timeouts, and this lets the system complete the page.

Even though our test system does not permit motion beyond program limits, it is always wise to include limit sensors when building a motion-controlled tester. Limit sensors indicate that the table is nearing the end of its travel. We added limit sensors to allow the microcontroller to cut power when the table reaches the end of its travel. In fact, those sensors proved useful during software development when the table went too far.

Overall, we have been very happy with the results from our testers. While the first time through this approach presented certain challenges, we now have a test-setup template that we can reuse when designing new test stations. In the long run, our system has reduced development time as well as training time and overall costs. T&MW

Sean O'Leary *is a senior electrical engineer at Artis. He received his ME in electrical engineering from the University of Utah in 1999. olearys@artisllc.com.*

Jed Marti *is chief scientist of Artis. He received a PhD in computer science from the University of Utah in 1980.*

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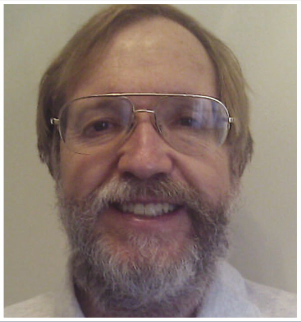
Modules gain EMC standard

By Richard A. Quinnell, Contributing Editor



Fred Heather
PAR-1688 W.G. Chair
Electromagnetic environmental effects lead for JSF

For the past four years, an IEEE working group has been developing an EMC (electromagnetic compatibility) standard that addresses the design and test needs of plug-in cards for modular systems such as PXI. While the initial efforts of the PAR-1688 Replaceable Electronic Modules working group have targeted EMC qualification for military systems, the methodology is applicable in the commercial sector as well. I discussed the standard with the working group's chair, Fred Heather, who is the electromagnetic environmental effects lead for the Joint Strike Fighter program.

Q: What was the motivation for developing PAR-1688?

A: Integration has been turning systems that used to be large boxes into small cards in a cage that offer modularity for repair or upgrade replacement. But most current EMC compliance standards require retesting of an entire system even if only one module changes. A full system qualification test is expensive, so we wanted a standard that could qualify just the module. There will still need to be an initial system-level qualification, but by having standards for individual modules, we can simplify the maintenance of compliance when modules change. Module-level standards also help assure system designers that their final result will pass qualification testing

Q: How would system designers apply the standard?

A: We envision a multiple choice based on market conditions. One way is for the system designer to tell the module provider what qualifications level the module is to achieve. Another way is for the module developer to target a qualification level based on expected customer applications. In either case, the standard addresses only module performance, not backplanes or cables. The test fixture we developed eliminates all cabling issues common to system-level EMI (electromagnetic interference) testing.

Q: What is the timeline for release?

A: We have completed the design limits and test requirements portion of the standard and are working on the appendix, which covers applications guidance. Our goal is to have a review draft to the EMCS Standards Committee by the time the IEEE International Symposium on EMC is held in August. Comment and review followed by approval and release could come by the end of the year.

Q: Any surprises during development?

A: We did have to develop some new test methods. Current standards address near-field magnetic coupling but not electrical coupling. We had to create a way of measuring high-impedance electric fields at distances of a centimeter or so. Also, when we started reducing field-strength test levels (to account for the effects of shielding), we got below the level that standard probes could sense, and we had to solve that problem.

Q: What is the applicability of the PAR-1688 standard?

A: The initial standard addresses the needs of systems that will be tested to MIL-STD-461, including air, ship, and ground-based systems. Our plan is to follow up by adapting the standard to address commercial applications such as networking and industrial systems. We will adopt the same test approach and methods and adjust the compliance levels, bandwidths, and such to match various application needs.

Q: Is there a way for PXI users to benefit from the standards effort now?

A: Become part of the committee. The committee is open to the industry and welcomes new members. There is a lot to be learned as we share understanding and insights. □

INSIDE THIS REPORT

GUEST COMMENTARY

Testing more with less using PXI

By Matthew Friedman

As the economic uncertainty remains, we all have to make the hard choices about how to do more with less. For more than a decade, this has been one of the key goals of the PXISA (PXI Systems Alliance) when developing and now evolving the PXI standard. This is most evident in the fact that the modular PXI architecture

shares a common backplane, power supply, microprocessor, display, and metal frame across all instruments in the system to remove the unnecessary duplication of these components in rack-and-stack systems. This results in significant cost, space, and power savings when considering the estimated 100,000 PXI systems to be deployed by the end of 2009, contributing to a combined reduction of more than 600,000 power supplies, microprocessors, displays, and metal frames that would have otherwise been purchased and deployed for each instrument in a system with a traditional rack-and-stack approach.

PXI also compares favorably budget-wise with other modular standards since it is based on a COTS (commercial off-the-shelf) approach to system components. For example, test system integrator NTS saved more than $20,000 per avionics test system by switching to PXI from VXI. Engineers can further maximize the price and performance of their PXI systems as a result of the high level of interoperability and wide selection of products offered by more than 60 PXI vendors. Furthermore, PXI multivendor support offers a cost-effective upgrade path to enhancing the processing performance or I/O capabilities of a PXI system by only adding the required functionality and thus preserving the initial investment.

Looking forward, PXI will continue to deliver a cost-optimized solution for many automated test, measurement, and control applications. The COTS-based, modular-system architecture of PXI contributes to a lower system cost by eliminating redundant system components, using less power and rack space, and delivering industry-leading interoperability for optimized multivendor solutions. This approach enables engineers to assemble high-performance systems with measurement capabilities from DC to 26.5 GHz while paying only for the required functionality and performance. □

Matthew Friedman is the PXI platform manager at National Instruments and the PXISA marketing co-chairman. matt.friedman@ni.com.

HIGHLIGHTS

Digitizers gain high-impedance mezzanine

The U1061A (8-bit) and U1062A (10-bit) Acqiris high-speed PXI digitizers from Agilent Technologies feature an optional high-impedance mezzanine that enables them to be combined with a signal probe for applications such as telecommunications and semiconductor component testing.

The U1062A is a 4-Gsamples/s, 3U PXI digitizer with input bandwidths of up to 2 GHz and acquisition memories of up to 256 Msamples/channel. The dual-channel U1061A, with up to 1-GHz of instantaneous bandwidth, provides synchronous sampling on both input channels of 1 Gsamples/s with up to 8 Msamples of acquisition memory. In single-channel applications, both digitizers permit channel interleaving, providing 2 Gsamples/s and 16-Msample memory (U1061A) and 4 Gsamples/s and 512-Msamples memory (U1062A). www.agilent.com.

PXISA membership grows to 59

The PXISA (PXI Systems Alliance) reports that it welcomed 14 new members in 2008, bringing its total membership to 59 companies. New executive members are Averna, BAE Systems, LeCroy, and One Stop Systems. The 10 new associate member companies are Beijing Control Industrial Computer, C & H Technologies, Corelis, DAQTron, EADS North America Test and Services, Elektrobit Austria, Elma Electronic, Integrated Device Technology, Ranatec Instrument, and Tabor Electronics. www.pxisa.org.

KineticSystems releases ADC module

The CP246 CompactPCI/PXI Bridge signal-conditioning module from KineticSystems incorporates eight signal-conditioning channels, eight independent 16-bit ADCs, and 16 multifunction digital I/O channels. By combining all of these functions in a single module, the CP246 eliminates the need for complex field wiring. The company claims that this reduces system noise while increasing the accuracy of the data measured.

KineticSystems reports that typical applications for the single-width module include rocket motor testing, wind tunnel testing, vibration and torque measurements, RTD temperature measurements, and general-purpose digital control or monitoring. Base price: $400 per channel. www.kscorp.com.

Facing legacy issues in PXI systems

By Richard A. Quinnell, Contributing Editor

In the 10 years since its introduction, PXI has seen its share of technical changes, including rising performance specifications for modules and the evolution of the PC-oriented hardware and software at PXI's core. Applications have also changed, with many PXI systems becoming embedded parts of larger test and measurement systems. The resulting combination of long-term fixed installations and changing technology has raised a specter of legacy issues in PXI designs that test engineers will need to exorcise.

It's not a particularly frightening specter. Maintaining compatibility has been a key goal of the PXISA (PXI Systems Alliance) as it has handled technical evolution throughout its history. Even major changes such as a move from the parallel bus of PXI to the serial bus of PXIe (PXI Express) have provided for the reuse of existing system components.

For the move to PXIe, the PXISA defined a hybrid system slot that would accept cards of either bus type (**Figure 1**). This hybrid slot allows developers to populate a system with older cards and then replace them with PXIe upgrades as needed without altering system configuration. Even software could remain unaffected; with PXIe, the bus change is transparent to the OS (operating system) and applications layers of software.

Despite these efforts, legacy issues are beginning to arise in PXI systems. In part, these issues stem from an increasing use of PXI as an embedded component of test and measurement systems. The intergeneration compatibility built into PXI allows virtually unlimited reuse of boards and applications software and simplifies the introduction of new capabilities when an engineer is reconfiguring a PXI chassis for various bench uses. When the system elements and configuration need to remain stable for many years as an embedded instrument, however, individual changes that have little impact on bench reconfigurations can accumulate to create significant problems.

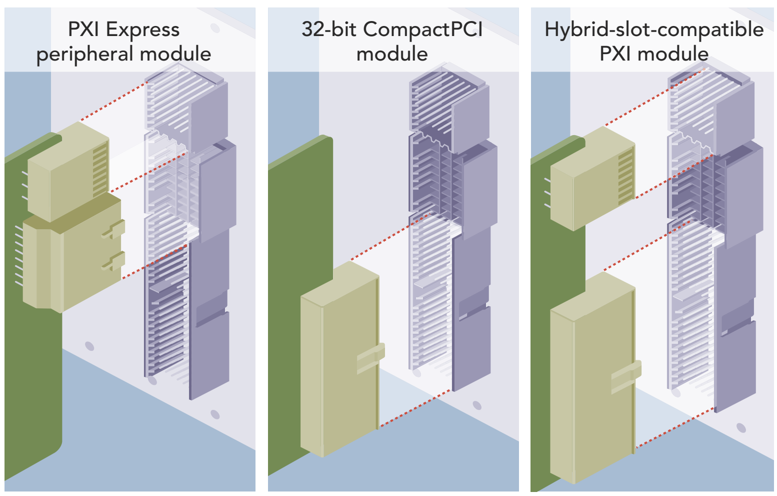


Fig. 1 The PXI standard has maintained a high level of compatibility as it evolves, such as the definition of a hybrid card slot to accept both the new PXI Express as well as legacy CompactPCI and PXI modules.

Legacy concerns vary

The types of legacy concerns that arise depend on what the test engineer is trying to accomplish. Simply changing a connector to make a PXI card compatible with a hybrid slot has little or no effect on the card's functionality (**Figure 2**). But when the goal is to maintain an older existing system essentially unchanged during a long installed life, engineers may find it difficult to obtain the technical support or replacement cards they need. The continual evolution and obsolescence of PC processors and OSs—particularly Windows—affect PXI-based systems, especially those that include a PCI or CompactPCI card.

Parts obsolescence becomes a concern when identical replacements rather than functional equivalents are needed to avoid long and costly recertification testing, as in military systems. "The biggest issue we have is with embedded control processors on modules," said Mike Dewey, senior product marketing manager at PXI equipment maker Geotest. "We are at the mercy of the Intel roadmap and can expect only a three- or four-year run life on a specific component."

Board vendors can generally handle the situation by maintaining functional equivalence through processor generations. When exact component replacement is a requirement, however, or changes in clock speed and other processor timing create problems elsewhere in the system, test engineers may have a problem despite equivalent functionality. "Sometimes it is better to stick with what you have and go to the secondary market that is reselling older products," said Dewey.

Although software doesn't "wear out," the obsolescence of an OS can create system-maintenance challenges. "Many [PXI] vendors support a couple of OS generations back," said Matt Friedman, PXI platform manager at National Instruments, "but it is a moving target, and older versions lose support over time." Geotest's Dewey also pointed out that third-party applications software providers may also gradually drop support for older versions and OSs.

The support issue is also a concern for developers seeking to upgrade existing systems with minimal impact. Replacing a module in order to get higher performance or gain additional features may not be possible if the legacy system's OS is unsupported.

"New module introduction becomes problematic under an older OS," said Tim Carey, PXI product manager at instrument maker Aeroflex. "Our new products aren't even engineered for Windows 95 or NT anymore, so we don't know what their behavior would be in a legacy OS system." Even if a new product supports a legacy OS, some new card features may not be accessible under that older version.

Upgrades create challenges

Developers contemplating upgrades to system hardware also face additional issues. An older card cage, for instance, may not offer the power mix that newer boards require. "Logic interfaces have moved from 5 V to 3.3 V," noted Geotest's Dewey. If an engineer moves a system to a new chassis to gain PXIe support, older cards that use the local bus will lose that backplane connection in a hybrid slot. Even if not using the local bus, older cards that include the J2 connector will not fit into a hybrid slot, although that can be readily corrected. "Most vendors will take their card back and swap out connectors to preserve their customer's investment, even if it is several years old," said Dewey.

If it is the software that needs to be upgraded—for instance, to gain access to new board features or because of a new release for third-party application software—then older boards generate a different concern. "When updating the OS, developers need to make sure their vendor provides drivers for their legacy boards that support the latest and greatest," noted NI's Friedman. Also, developers will need to make sure the processors in older cards can handle the demands of the upgraded OS.

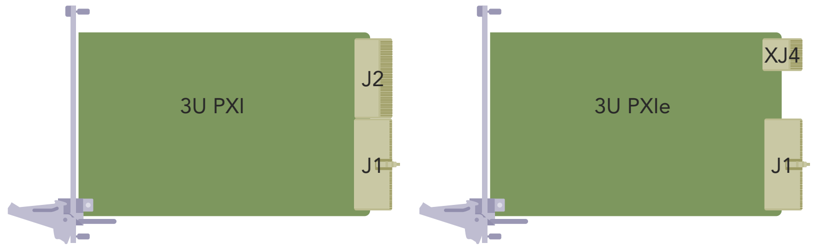


Fig. 2 **Modifying an older PXI module (left) to make it compatible with a hybrid slot can be as simple as swapping a connector (upper right); most vendors will perform the swap for a modest charge.**

This interaction of hardware and software can quickly snowball, with one change triggering a need for additional changes elsewhere in the system. Engineers facing such an extended system upgrade may want to look beyond their immediate need to avoid repeating the experience.

"You need to take stock of the whole system status such as where in their life cycle all the components are and how many years the system will need to run, then ask suppliers their support policy and how long things have been in production," said Dewey. "If it's more than five years, they [the components] may not be available much longer. The last thing you want to do is make a whole system upgrade, then find out later that a few more parts became obsolete."

TABLE 1. HARDWARE AND SOFTWARE LEGACY ISSUES FOR PXI TEST SYSTEMS

Goal	Hardware considerations	Software considerations
Maintain	Embedded controller obsolescence can reduce parts availability. CompactPCI card changes can trigger recertification.	Board-vendor driver support for older OS versions may decline. Support for older versions of third-party software may decline.
Upgrade	Card supply-voltage and current changes may affect cage requirements. DMA (direct-memory access) timing changes can affect system behavior. Hybrid slots will not support PXI local bus use.	Drivers for new cards under old OS may not be available. Older processor may not be able to run new OS. Older OS may not support new card functionality. A single hardware or software change can snowball to affect more of system.
Future-proof	PXIe hybrid compatibility retains upgrade options. Partitioning choices can affect ease of updating.	Design for processor speed independence to accommodate CPU changes. Design for code parallelization to take advantage of multicore. Use of RTOS or Linux can avoid Windows legacy issues.

Future-proofing design

As PXI increasingly becomes an embedded test element, such legacy issues will continue to grow in importance. Engineers creating new systems may want to take steps to mitigate these legacy concerns and future-proof their designs.

Aeroflex's Carey pointed out, for instance, that the system controller is the technology element changing at the fastest pace, making embedded Windows-compatible processors riskier. Added Dewey, "If someone really wanted to get longevity out of their system design, they might want to use an external controller based on an industrial PC."

Another factor to consider is the potential of PXIe. Not every PXI module will migrate to the standard, but many that need high performance eventually will. Developers should consider including hybrid slots in their test system to allow for such migration and should also make sure that the modules they choose are hybrid compatible.

In addition, developers may want to partition their system functionality among modules to simplify future upgrades. Digital technology evolves faster than analog, for instance, so there may be an advantage in separating signal conditioning from digitization steps.

"In our signal generator design, we have a synthesizer module and an RF output module with frequency multipliers," said Aeroflex's Carey. "We segmented it that way so that as requirements shift, only one part of the system changes. Customers upgrading from 3 GHz to 6 GHz, for instance, only needed to replace one module." Too much segmentation can become a drawback, however. "We could have separated out the baseband, too, but then size, cost, and calibration became issues," Carey said.

To help future-proof software, developers should ensure that applications code behavior is independent of processor changes. "If you use good programming practices, such as no hard timing loops, then moving to a faster processor is not a problem," said Dewey. "You need to use development tools that help keep you independent of the processor speed."

Developers might also want to structure code to take advantage of parallel processing. Processor technology has stopped evolving toward higher clock speeds for increased performance and is now moving to multiple cores on chip. The move to multicore can provide faster computing and can also change the way a test runs from sequential steps to simultaneous operations in parallel, but only if the code structure supports parallelization.

Moving away from the Windows OS family is also a possibility. For many applications, a real-time OS might be appropriate, especially if deterministic or mission-critical operation is important in the testing. For others, a switch to Linux might help prevent OS obsolescence from forcing legacy systems to change.

Finally, developers should consider getting expert advice. "Work with your vendor to find the correct components for your system that will have long working lifetimes," said NI's Friedman. "They will help address specific needs and recommend choices." These may end up being vendor-specific, but with the right provider, the risk is small and the potential benefits great if your PXI system design is to have a long and productive life. □

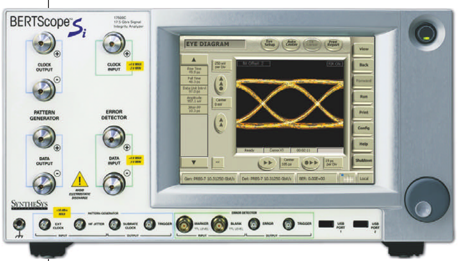
PRODUCTUPDATE

BertScope boosts speed, decomposes jitter

Synthesys Research has boosted the speed of its flagship BertScope BER (bit error rate) tester from 12.5 Gbps to 17.5 Gbps. With their higher speed, the 17500A and Si 17500C instruments can perform BER tests and display eye diagrams on 14-Gbps Fibre Channel devices and systems. They can also analyze serial data streams from 500 Mbps to 17.5 Gbps. The 17500C adds a jitter source for receiver testing.

The company has also added a software option called Jitter Map to the BertScope line. Jitter Map uses the BertScope's BER tester to decompose jitter into random and deterministic jitter, then further decomposes deterministic jitter into data-dependent jitter, bounded uncorrelated jitter (such as sinusoidal), intersymbol interference, and other components, displaying them as a map of total jitter.

Jitter Map analyzes signals for bounded uncorrelated jitter by looking at the same bit in a PRBS pattern. Such analysis lets you find which bits contribute to bit errors. The software also contains a divider that lets you look at a clock rate divided by two, four, five, and so forth and display an eye diagram for each one.



This lets you find which clock signals in a circuit contribute to periodic jitter.

To reduce the time needed for making jitter and BER measurements on long bit patterns such as PRBS31, Jitter Map uses data obtained from short patterns such as PRBS7. It then measures total jitter on the longer pattern and calculates the jitter components based on the shorter patterns.

Base prices: BertScope 17500A—$185,000; BertScope Si 17500C—$235,000; Jitter Map—$15,000. *Synthesys Research, www.bertscope.com.*

Move VXI modules to LXI

Bustec, a manufacturer of VXI data-acquisition products, has introduced an LXI chassis that accepts up to eight of the company's I/O modules. The ProDAQ1600 accepts I/O modules originally designed for the company's VXI cards. It also lets you use Ethernet as your data-acquisition bus in place of internal buses such as PCI or PCI Express.

Because of the half-rack, 1U-size of the ProDAQ 6100, you can install two chassis side-by-side in a standard 19-in. instrument rack. I/O cards include analog input, analog output, digital I/O, serial communications (RS-232, RS-485), and counter/timer. With the company's 24-channel analog-input cards, you can use up to 192 channels in a single chassis.

The ProDaq 6100 is a Class B LXI instrument, which lets you synchronize measurements with 20-ns accuracy. Class B LXI instruments support the IEEE 1588 timing protocol.

Prices: ProDAQ 6100—$950; I/O modules—$300 to $5000. *Bustec, www.bustec.com.*

ADS simulator speeds eye measurements

Agilent Technologies has introduced a million-bit-per-minute signal-integrity channel simulator for multigigabit chip-to-chip data-link design. The channel simulator—part of Agilent's ADS (Advanced Design System) EDA software platform—allows an interactive eye-diagram measurement from channel simulations performed within the ADS signal-integrity design and analysis environment.

The most common applications for the ADS channel simulator are design and verification of the chip-to-chip multigigabit-per-second serial links found in many consumer and enterprise digital products—from laptop computers to data center servers to telecommunication switching centers to Internet routers. The simulator helps signal-integrity engineers take into account physical phenomena such as impedance mismatch, reflections, electromagnetic coupling, crosstalk, and microwave frequency attenuation due to the skin effect and dielectric loss tangent.

The ADS channel simulator allows engineers to perform "what-if" design-space exploration. To aid this workflow, the ADS channel simulator uses impulse-response analysis to automatically extract a linear FIR (finite input response) model from any combination of ADS circuit-level and physical-level components. This results in simulation throughput of more than 1 million bits per minute. Fast eye measurement lets engineers produce the resulting eye measurements—and optimize transmit and receive equalization—in serial links such as PCI Express, USB 3.0, and 10-Gigabit Ethernet.

The channel simulator will be available as part of the ADS 2009 release. It is offered as part of both the legacy E8885 Convolution Simulator and its successor, the W2302 Transient Convolution Element in the ADS.

Base price: $26,000. *Agilent Technologies, www.agilent.com.*

Corelis unveils entry-level I2C bus analyzer

Corelis has introduced the BusPro I2C, an entry-level bus analyzer for I2C hardware debugging, software development, and in-system programming. Applications for the BusPro I2C include embedded software and firmware development, hardware debugging, and system-performance verification. The analyzer also facilitates the programming and verification of I2C-compatible EEPROMs. It supports Standard-mode, Fast-mode, and Fast-mode Plus with I2C bit rates of up to 5 Mbps.

For software development, the BusPro monitors and logs I2C bus traffic in real time. Hardware debugging features include exercising the I2C bus and communicating with its peripheral components.

The analyzer provides a USB 2.0 interface, two general-purpose I/O channels, programmable trigger events, and automatic detection of bus voltage and signal thresholds.

Price: introductory price—$995; list price—$1250. *Corelis, www.corelis.com/buspro.*

UEI unveils six-slot GigE I/O chassis

United Electronic Industries has released the DNR-6-1G, a portable Gigabit Ethernet I/O chassis with six slots. UEI calls the new chassis the "HalfRack," as it offers all the features of the company's DNR-12-1G Racktangle 12-slot chassis in a half-rack-width configuration.

The HalfRack's six I/O slots provide up to 150 analog inputs, 192 analog outputs, 288 digital I/Os, 48 counter or quadrature channels, 72 ARINC-429 channels, and 24 serial or CAN bus ports. The DNR-6-1G is electrically compatible with the "cube" form factor that UEI uses for some I/O boards, which means there are currently more than 30 I/O modules available for the chassis.

The UEIDAQ Framework software provides an application programming interface that supports Windows, Vista, and Linux as well as real-time operating systems such as QNX, RTX, and RT Linux.

Price: $3350. *UEI, www.ueidaq.com.*

EXFO platform leverages OTN test suite

EXFO now offers an EoOTN (Ethernet over optical transport network) and advanced OTN analysis suite for testing packet-based OTNs. The FTB-8130NG Transport Blazer and the FTB-8130NGE Power Blazer test modules enable the testing of EoOTN through the generation and mapping of 10-GigE LAN traffic directly into OTU1e and OTU2e payloads. In addition, EXFO offers modules that support the ability to analyze and manipulate OTN overhead bytes and to intrusively test OTN signals in through mode at up to 43 Gbps.

EXFO Electro-Optical Engineering, www.exfo.com.

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225 Wyman St., Waltham, MA 02451
781-734-8423 Fax: 781-734-8070
Sales e-mail: tmwsales@reedbusiness.com
Editorial e-mail: tmw@reedbusiness.com
Web: www.tmworld.com

BUSINESS STAFF

Publisher: Russell E. Pratt
rpratt@reedbusiness.com

Associate Publisher: Judy Hayes
judy.hayes@reedbusiness.com

Online Account and Marketing Manager:
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[An exclusive interview with a technical leader]

HARALD KRUGER
CEO
Pendulum Instruments
Stockholm, Sweden

In 1998, Harald Kruger acquired Pendulum Instruments as a spinoff of Philips Electronics and became the company's CEO. Over the last decade, he has successfully built the 40-year-old company into a leading innovator in solutions for calibration, measurement, and analysis of time and frequency. In 2005, Kruger led Pendulum's acquisition of California-based XL Microwave, expanding Pendulum's high-frequency capabilities. Last year, Pendulum Instruments became part of the Orolia Group, a precision electronics technology firm based in France. Kruger earned his MSc degree in economic science at Linköping University in Sweden in 1994.

Contributing editor Larry Maloney conducted an e-mail interview with Kruger on the growing importance of time and frequency measurements in a variety of applications.

When time and frequency matter

Q: What test challenges drive the need for greater time and frequency accuracy?

A: In communications, for example, the move from analog to digital TV is one important driver. Another driver is the deployment of higher bandwidth 3G networks, including WiMAX, with tight demands for frequency control and time synchronization.

Q: How do Pendulum's products address these challenges?

A: Our CNT-90 family of time/frequency analyzers is optimized for high measurement speed, which is crucial in many applications. In R&D, you need to follow transient frequency behavior, start-up behavior, fast modulation, radio-channel-switching time, frequency settling, and other parameters. For long-term monitoring of frequency or time intervals, as in applications where you must compare two reference frequencies, our CNT-91 time/frequency analyzer can capture and continuously output up to 10,000 results per second to a controller for an unlimited time.

Time and frequency calibrations basically involve an accurate frequency reference, the actual signal under test, and an accurate comparator between these two signals. High-frequency accuracy in a measurement or calibration situation is always limited by the accuracy of the frequency reference. Pendulum offers several frequency standards with very accurate rubidium clocks, both GPS-controlled and stand alone. Our latest product launch, the CNT-91R, combines an integrated rubidium clock with a high-performance frequency analyzer. So, you get a high-accuracy frequency calibrator in one portable box.

Q: What are your target industries?

A: Oscillator manufacturers, aerospace/defense, metrology labs, telecommunications companies, and a variety of electronics industries. Our customers include such enterprises as Ericsson, USAF, Royal Air Force (UK), NDK (Japan), and Foxconn, as well as mobile telephone operators in more than 50 countries.

Q: What are the performance advantages of dedicated frequency analyzers?

A: Unlike a digitizing multipurpose instrument, the CNT-91 requires the time stamp of just two signal zero crossings to calculate frequency between sample points. A digitizing type of instrument would need thousands of sample values during the measurement to identify and calculate frequency. Even if these samples are captured at high speed, the high number of data points needed slows down the calculation.

For time-interval measurements, such as the skew between antenna signal outputs, the very high resolution of a 50-ps single-shot in CNT-91 corresponds to a 20-GHz sample clock frequency in a digitizing solution. To reach 50-ps resolution in a unit with a 200-MHz sample clock would require the average of 10,000 time intervals. The CNT-91 does it in one single interval. That's a big boost in throughput for test engineers.

Q: Do more customers want system solutions?

A: We see a growing demand from customers, such as high-tech labs, to set up large frequency-distribution systems. These typically involve fiber-optic solutions that distribute signals over long distances without EMI [electromagnetic interference]. One telecom customer needed to deliver two different frequencies from the 10th floor of a building to several labs on other floors. Pendulum provided a flexible, economical solution consisting of two GPS-controlled frequency standards, four distribution amplifiers, and multiple racks with output boards to fiber. T&MW

Harald Kruger addresses more questions on time and frequency applications in the online version of this interview: www.tmworld.com/2009_03.

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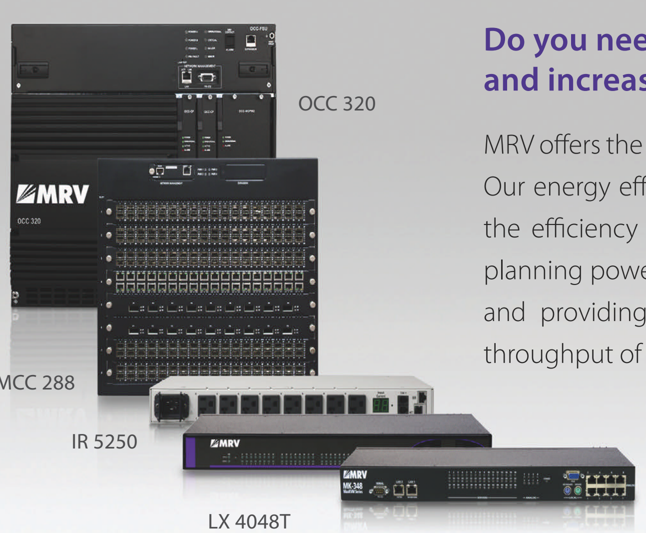

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