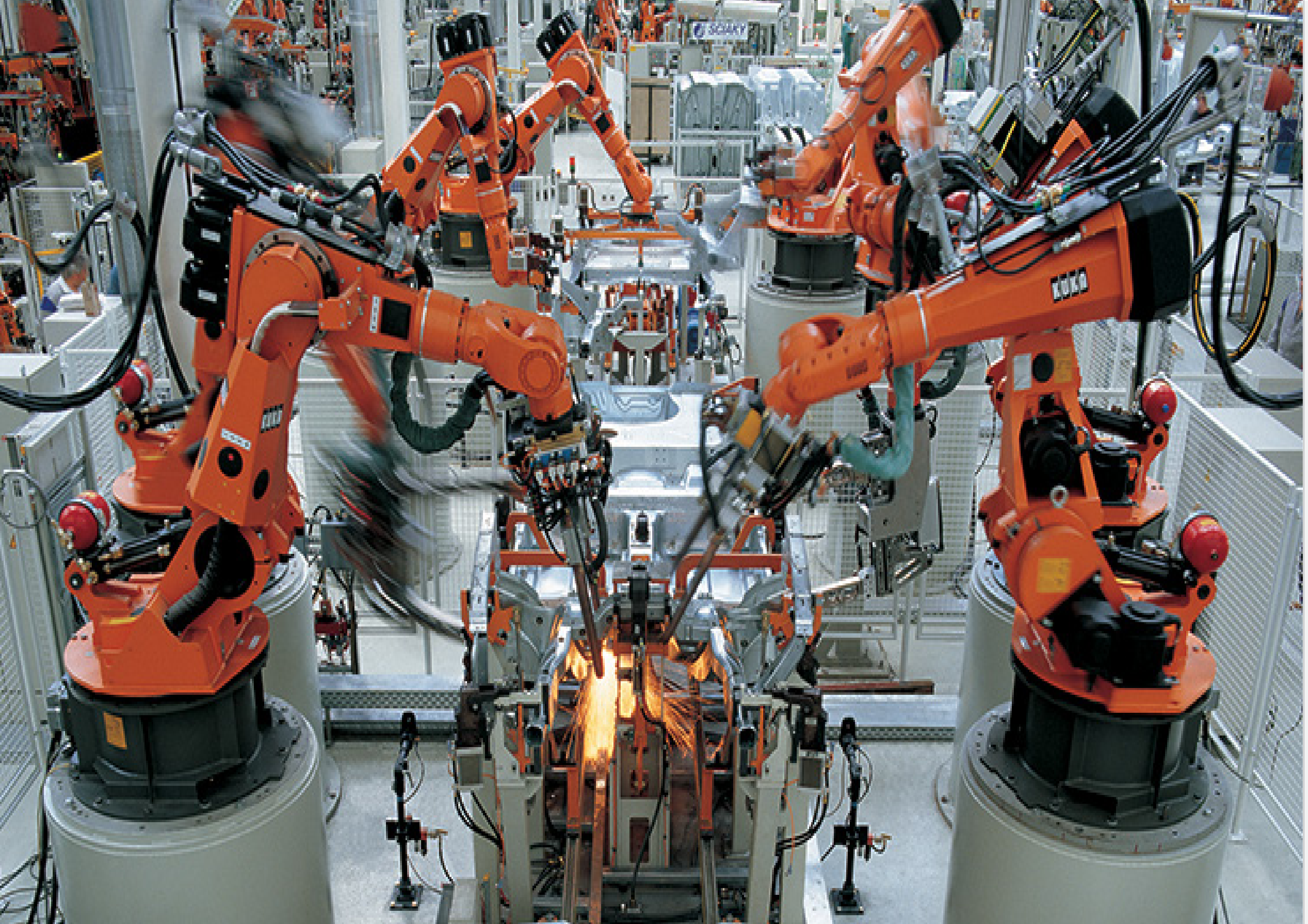
Automated Test Outlook 2014

A comprehensive view of key technologies and methodologies impacting the test and measurement industry.

- Business Strategy
- Architecture
- Computing
- Software
- I/O

NATIONAL INSTRUMENTS



A Technology and Business Partner

Since 1976, companies around the world including BMW, Lockheed Martin, and Sony have relied on National Instruments products and services to build sophisticated automated test and measurement systems.

Test delivers value to your organization by catching defects and collecting the data to improve a design or process. Driving innovation within test through technology insertion and best-practice methodologies can generate large efficiency gains and cost reductions. The goal of the Automated Test Outlook is to both broaden and deepen the scope of these existing efforts and provide information you need to make key technical and business decisions.

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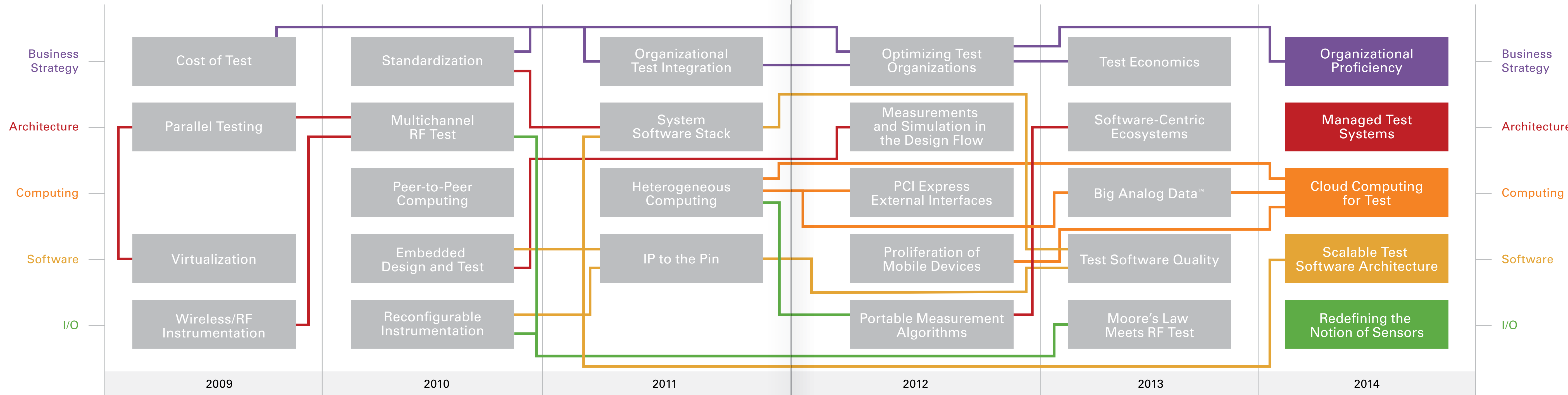


How We Arrived at the Trends

As a supplier of test technology to more than 35,000 companies worldwide each year, we receive a broad range of feedback across industries and geographies. This broad base creates a wealth of quantitative and qualitative data to draw on.

We stay up to date on technology trends through our internal research and development activities. As a technology-driven company, we invest more than 16 percent of our annual revenue in R&D. But as a company that focuses on moving commercial technology into the test and measurement industry, our R&D investment is leveraged many times over in the commercial technologies we adopt. Thus, we maintain close, strategic relationships with our suppliers.

We conduct biannual technology exchanges with key suppliers that build PC technologies, data converters, and software components to get their outlook on upcoming technologies and the ways these suppliers are investing their research dollars. Then we integrate this with our own outlook. We also have an aggressive academic program that includes sponsored research across all engineering disciplines at universities around the world. These projects offer further insight into technology directions often far ahead of commercialization.

And, finally, we facilitate advisory councils each year for which we bring together leaders from test engineering departments to discuss trends and share best practices. These councils include representatives from every major industry and application area—from fighter jets to the latest smartphone to implantable medical devices. The first of these forums, the Automated Test Customer Advisory Board, has a global focus and is in its 14th year. We also conduct regional meetings, called regional advisory councils, around the world. Annually, these events include well over 300 of the top thought leaders developing automated test systems.

We've organized this outlook into five categories (see above figure). In each of these categories, we highlight a major trend that we believe will significantly influence automated test in the coming one to three years. We update the trends in these categories each year to reflect changes in technology or other market dynamics. We will even switch categories if the changes happening are significant enough to warrant it.

As with our face-to-face conversations on these trends, we hope that the Automated Test Outlook will be a two-way discussion. We'd like to hear your thoughts on the industry's technology changes so we can continue to integrate your feedback into this outlook as it evolves each year. Email ato@ni.com or visit ni.com/test-trends to discuss these trends with your peers.

Organizational Proficiency

People are the most important asset in any organization. For engineering organizations, the aging and diminishing engineering workforce is placing more importance on hiring for long-term success than ever before. Fewer engineers are entering the field of study, and those choosing an engineering vocation do not specialize in test. According to the 2012 UBM "Mind of the Engineer" survey, the typical engineer has 19 years of experience, but one of every five engineers has started his or her career in the past decade. In a few years, there will be more engineers retiring than entering the workforce.

To address the shrinking talent pool, test managers are looking to grow their organizational proficiency using a three-pronged strategy focused on hiring with the long term in mind, onboarding to ensure a successful acclimation for new hires, and investing in the team through training programs.

CULTURE VERSUS EXPERIENCE IN HIRING

With demand growing and supply diminishing, choosing the right candidate the first time is paramount to ensure the long-term success of the department. Hiring managers frequently face the challenge of selecting a few potential interviewees from a large selection of qualified candidates, but they often find success vetting candidates with a heavy emphasis on softer skills such as communication and team-building skills. Though these softer skills are difficult to quantify, managers at best-in-class companies find more success in hiring candidates with a stronger cultural fit than candidates with experience and deeper skill sets, and these managers do not rush to fill an open position too quickly when those softer skills are not present. Best-in-class companies succeed with this strategy because they are properly structured to support an onboarding program and a plan for growing proficiency within the team.

ONBOARDING

Studies have estimated that the replacement cost of a salaried employee is six to nine months' salary, not including intangibles such as lost intellectual property and expertise. Though attrition can result from many factors, it is hard to ignore the popular maxim, "People don't leave companies. They leave managers." What can a test manager do to ensure a higher retention rate and prevent the extensive repeat costs of hiring, onboarding, and training? Best-in-class test managers have found that implementing a formal onboarding program has a significant impact on employee retention.

Test managers interviewed from larger organizations found their HR departments have well-documented onboarding processes, while those from smaller organizations felt the process lacked formality. The less formal programs failed because of low accountability. Responsibilities and execution belonged to both HR and the hiring manager, but this task was often delegated to an experienced senior employee with no time to execute, track, and measure the process. Best-in-class test organizations ensured a higher retention rate with a dedicated and accountable mentor who can spend time and attention on one-on-one meetings and project reviews.

CONTINUED LEARNING

Building a strong team with low turnover hinges on the continued learning of senior team members. UBM asked over 2500 engineers which challenges keep them up at night, with the No. 1 response being, "keeping my skills up to date." An additional UBM survey question of over 2000 engineers showed that 61 percent strongly agreed their job requires they continue to learn new concepts. This trend will continue to grow as most individual contributors are regularly seeking to "sharpen the saw" and improve their skills to stay relevant.

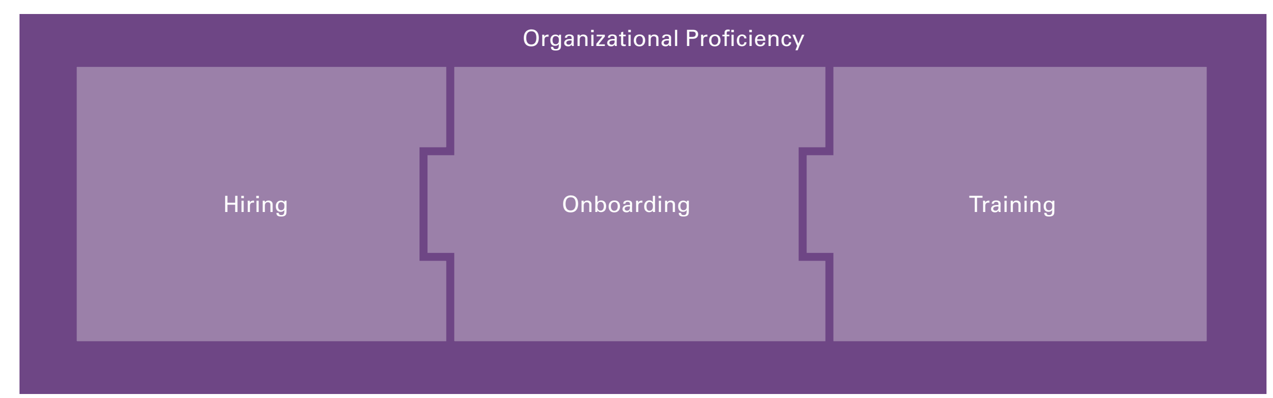
Test managers with strong training plans have found success using an organizational program called a center of excellence (COE). A COE refers to a team that provides leadership, evangelization, best practices, and training for a focus area. The COE concept leverages observations from other best-in-class companies while incorporating training certifications to help drive multiple levels of core competency. A COE succeeds with a diverse set of group skills. The most advanced skill set makes up the smallest portion, the next layer is composed of those with intermediate skill, and the largest group is categorized as entry level. Using this model, senior team members with advanced skills can mentor the newer engineers and bring them up to speed in a more comfortable way. The COE provides the structure necessary for organizationally proficient teams to effectively onboard and hire for culture.

Though there isn't one training strategy model that fits all companies, it is common to incorporate expertise from external partners. Companies can leverage a partner's core competencies to develop a specific training program tailored to the training strategy as well as to provide scale. An ideal partner not only encourages wider organizational proficiency through communities with other best-in-class companies and the sharing of best practices but also provides a certification program.

Certifications effectively measure competency, act as a great motivator, and create a natural leadership/mentorship hierarchy within the community. For example, National Instruments offers multiple levels of certification for NI LabVIEW software, while IBM offers a formal professional certification program across its vast product categories spanning software, hardware, and solutions. Additionally, the aforementioned challenges of hiring a qualified new employee can be alleviated by listing a minimum certification requirement on a resume or by using certification exams to qualify interviewees during the actual interview. The availability and growing credibility of certifications have made them an important element in a successful training strategy.

> Our center of excellence designation highlights our focus on hiring skilled engineers, providing training, and setting standards of excellence in development and certifications. In a strong working relationship with NI, our engineers enjoy career growth and show great satisfaction in their careers and positions within the company.
>
> ■ *Raymond Cooper, Senior Engineering Manager, Ball Aerospace & Technologies Corp.*

Hiring, training, and retaining are important focus areas for test managers looking to build the highest performing team. Hiring challenges fueled by the diminishing engineering talent pool place even more emphasis on the need to become organizationally proficient by implementing a talent development program to retain and develop skills. Test managers who hire for culture fit, properly onboard new hires, and continually invest in training will ensure optimal team retention and cohesion.



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Managed Test Systems

As Moore's law continues to influence the performance and complexity of test systems, the need for robust system management capabilities is increasingly apparent. Test managers responsible for maintaining the uptime of a test system are looking for improved management features in their test equipment. Simply defined, manageability comprises the set of features that support the ability to identify and supervise a computing system. Borrowing from a rich heritage established in the information technology (IT) industry, manageability features enhance a test system's ability to perform its primary task (testing and measuring) by ensuring the components of the system are up to date, healthy, and meeting performance expectations.

In the same way that IT administrators rely on manageability features to efficiently maintain client and server computing assets in a corporate environment, test engineers and operators will benefit from manageability features when developing, deploying, and supporting the operation of test systems.

ELEMENTS AND OPERATING MODES OF MANAGED TEST SYSTEMS

Managed test systems are composed of the system infrastructure, peripherals, and hardware and software elements that manage them, including management consoles and APIs. For example, management console software, such as NI Measurement & Automation Explorer (MAX), can run directly on the test system being managed or be executed remotely via a network on a separate computer. In both cases, the management console issues configuration, calibration, platform monitoring, and deployment requests on behalf of the test engineer or operator managing the system, and the managed system fulfills those requests. In addition to vendor-provided management consoles, users can define their own or integrate manageability features directly into test applications using APIs. With these standard elements, manageability features can operate in two distinct modes: in-band and out-of-band.

In-band management uses the primary computing resources, including the system controller's main CPU, network interface, and operating system, to manage the system. In addition to running the test application, the system controller runs software to enable manageability features, including management consoles and supporting infrastructure. In this way, in-band management can support a rich set of manageability features while the system is operating in the "fully on" state. If the system controller is powered off, unprovisioned, or not operating normally because of a failure, out-of-band management is required.

Out-of-band management can be particularly useful for those diagnosing a system that has failed. While rare today, more test equipment is incorporating these features by using dedicated computing resources, including a secondary management processor, network interface, and operating system, to manage the test system independently of the system controller's computing resources. For example, if the system controller is unable to boot normally because it has experienced a hard drive failure, out-of-band management can be used to remotely power the system on and execute diagnostics on the hard drive, allowing for remote analysis to determine the cause of the failure. Further, because out-of-band management does not require the use of the system controller's computing resources, the system controller can remain fully dedicated to executing the application. This is particularly important for applications that are sensitive to disruptions in CPU or data bus usage, including real-time and high-throughput measurements.

TRENDS IN MANAGED TEST SYSTEMS

As modular instrumentation platforms continue to displace traditional box instruments, the need for asset management capabilities is increasingly important. Because modular test systems separate the system into components (system controllers, chassis, and instruments), the number of assets to be managed naturally increases. By knowing which test assets are being used and how they are being applied, test managers can lower costs by maximizing the use of available equipment. In a validation lab, for example, it is critical that the location and operational state of all assets are known so that components not actively being used can be redeployed in other test systems. The same applies to high-volume production test environments but on a much larger scale.

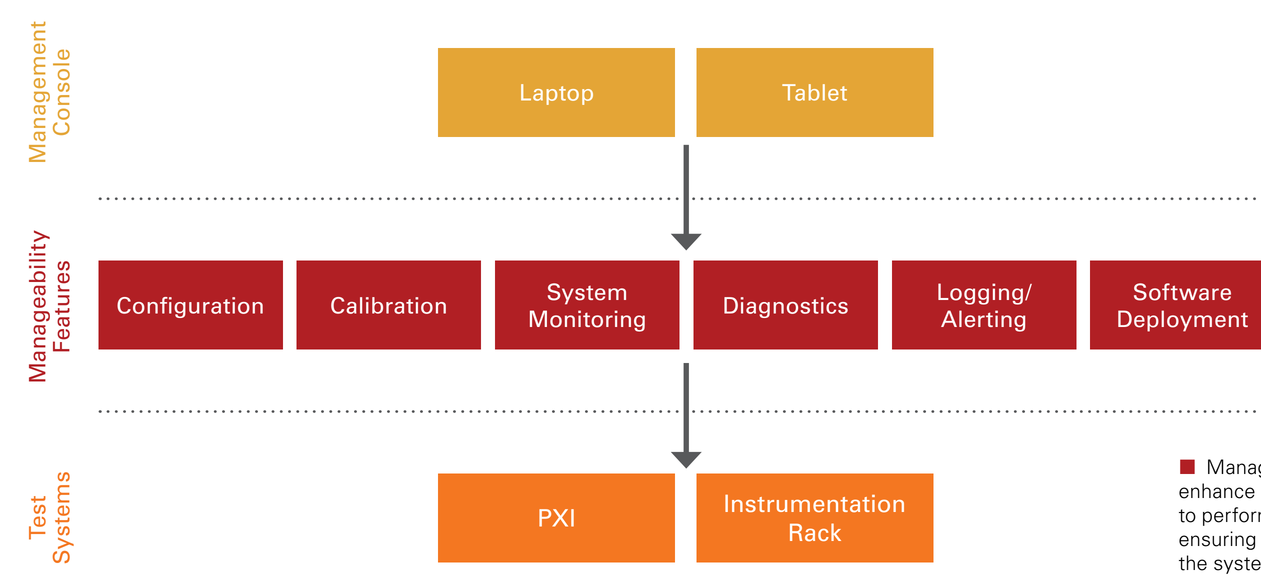
Increasingly complex measurement devices are also driving the need for comprehensive manageability support, particularly in platform monitoring and control. Modern modular instruments, especially RF instruments, offer unprecedented measurement flexibility and speed by taking full advantage of the power and cooling capabilities of the modular platforms that support them. Test system designers can maximize the long-term reliability, usability, and measurement accuracy of these systems by selecting platform elements that use monitoring and control features. For example, by monitoring the cooling requirements of the instruments in a chassis, a chassis can optimize its fan speeds to minimize acoustics. This is especially important in an environment where noise must be minimized such as a validation lab. Further, measurement accuracy is optimized when an instrument is operating as close as possible to its calibrated temperature. By monitoring the temperature of an instrument, a chassis can precisely control its fans so that the instrument can maintain a steady temperature at or near its calibrated value to ensure the integrity and repeatability of the measurement.

As the number and complexity of our automated test systems grow, systems management has become critical to ensuring our success. Manageability features directly drive efficiency, lowering our operating costs, increasing quality, and helping to ensure business continuity.

■ *Joseph Zingo, Senior Scientist, Harris Corporation*

BENEFITS OF A MANAGED TEST SYSTEM

Test managers can significantly benefit from improved manageability features, which lower the test system's integration risks by ensuring that issues can be diagnosed and resolved efficiently, especially for large and complex testers and testers in remote locations. Additional benefits include minimizing a test system's "time to value" by ensuring that initial and subsequent test station deployments can be managed in a fast and repeatable manner. Finally, manageability features lower the total cost of ownership of a test system by enabling the ability to proactively monitor and diagnose problems as well as convert unplanned outages into planned outages. Just as manageability features helped drive the transformation of the IT and telecom industries, they will play an increasing role in test systems in the years to come.



■ Manageability features enhance a test system's ability to perform its primary task by ensuring the components of the system are up to date, healthy, and meeting performance expectations.

Cloud Computing for Test

The cloud is drastically changing the information technology (IT) landscape. Companies such as Salesforce.com and Amazon Web Services (AWS) are rapidly transforming customer relationship management (CRM) and web hosting. They are also challenging Oracle and IBM in the process. What is the cloud and how will it impact the test and measurement industry?

The cloud simply represents a large number of computing servers connected together via some communication infrastructure. Cloud computing moves software applications, services, and sometimes just data offsite to a centralized location that is usually managed by a vendor.

Though it has mainly impacted IT and commercial applications so far, the cloud is well positioned to have a similarly transformative effect on automated test in the coming years.

CLOUD COMPUTING

Vendors such as AWS and IBM provide three basic types of cloud computing service models: Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS). These models offer an increasing set of capabilities and help users offload parts of their hardware and software stack ranging from the servers and the OS to the actual software application. For IaaS, the most basic cloud service model, the vendor offers the fundamental computing infrastructure such as servers, virtual machines, and storage. The user is responsible for providing an OS and the rest of the software stack. PaaS and SaaS build on the IaaS offering, with SaaS allowing most of the hardware and software stack to be managed by a vendor.

A good example of the SaaS model is Google Docs and Gmail. Users, via their web browsers, can access email, edit, store, and share various formats of documents, regardless of where they are and which computing device they use. Many corporations are actively moving their corporate email and other desktop productivity applications to web-based services because it reduces their investment and maintenance costs for complex desktop applications.

The benefits of cloud computing in the IT space are clear. Organizations can use it to optimize their hardware and software investment by paying for only what they need, easily scaling up or down their capacity to adjust to business changes, and minimizing their sustaining burden.

APPLYING CLOUD COMPUTING TO AUTOMATED TEST

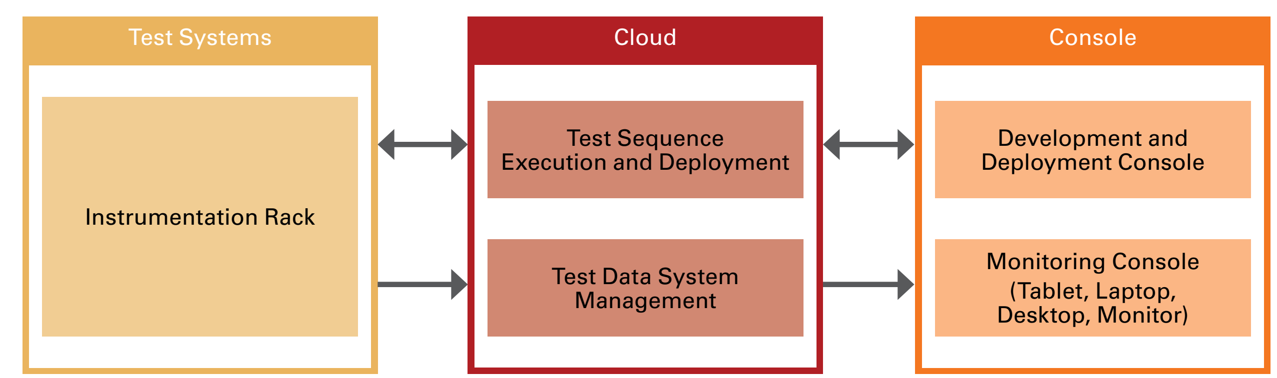
Every automated test system has at least one computing system that centrally controls all the instrumentation hardware and automates the testing or measuring procedure. PCs in various form factors, such as desktops, workstations, and industrial and embedded systems, have been used for this purpose.

Automated test systems will take advantage of cloud computing to process, store, analyze, and present test data such as data from measurement devices, data generated during the functional test of an electronic device, or perhaps data on the health of the automated test system itself. Automated Test Outlook 2013 described a concept called Big Analog Data™, which says raw data generated by automated test systems can be harnessed to provide real meaningful information in a way that has not been possible before. By leveraging the cloud, organizations can push raw data from all their automated test systems to the cloud for centralized processing, storage, and analysis. With data available from all sites and all systems for anyone's consumption, organizations can be more intelligent about the status of their test systems. Also, test engineers and managers can identify emerging trends in real time and proactively make decisions regarding parameters such as test station yield or test station health.

Besides test data management, an even more profound use of cloud computing for automated test will be the transformation of the development, deployment, and execution of actual test routines or sequences. Similar to how the IT industry is moving from desktop applications running on dedicated local servers to web-based applications running in the cloud, automated tests will move toward the web-based development of test programs that, once deployed, execute in the cloud while interacting with the measurement hardware of a specific test system. This transformation of the software stack for automated test systems will provide similar benefits to test departments that IT departments of various organizations are already realizing. Test organizations will have the ability to pay for the exact amount of computing performance and software licenses they are using. These resources will be highly elastic and scale up or down depending on required capacity. Test engineers can also focus more on their core functions and not waste time managing the local computing system in the automated test system. Support for existing test frameworks will be a key barrier to adoption for cloud-based automated test. Less intrusive cloud service models such as IaaS or PaaS can be deployed with a full cloud-based model of SaaS to address this challenge. Organizations that are concerned about software IP and data security along with system uptime can deploy a private cloud. A private cloud represents a cloud computing platform that is implemented within the organization's local firewall and managed by its own IT department.

Over the next three to five years, the test and measurement industry will start seeing more cloud-based development platforms beginning to unlock the full range of benefits for automated test systems. Various companies, including National Instruments, have already started offering products and services for test data management. Low upfront investment and the flexible capacity of cloud-based services will minimize the barrier to entry for other services tailored to meet the needs of test organizations seeking additional services or planning for future expansion.

> With cloud computing, testing can be controlled and results analyzed from virtually anywhere, anytime. This removes many of the time and place constraints in traditional test and measurement and affords the potent combination of increased flexibility coupled with time-to-market efficiency.
>
> *Dr. Tom Bradicich, Research & Development Fellow, National Instruments*



Cloud computing applied to automated test enhances test software deployment and test system management.

Scalable Test Software Architectures

Market demands are forcing companies across all industries to deliver increasingly complex and capable products in less time. Complexity is escalating as technologies converge within products, and product portfolios are expanding to deliver new capabilities. These demands have overwhelmingly shifted test organizations from rigid solutions with brittle code designed for specific products or purposes to software-based platforms that maximize longevity and scalability across a product's life cycle. Software makes it possible to address these challenges through the reuse of measurements, hardware, and IP; however, maximizing the benefit of a software-based approach requires careful planning and design by a core group of experts.

A scalable and extensible system that is resilient to constant change and demanding timelines requires significant up-front planning and design. With the proper investment, the development effort to support new technologies and functionality is minimized over time, along with the risk and cost of introducing changes to an existing system. This investment model requires considerable investment in tools, system architecture, and personnel training, but it is the optimal way to ensure test organizations can scale with future demands.

IDENTIFY THE COMPONENTS OF A SCALABLE SOFTWARE ARCHITECTURE

Scalable software architectures clearly define independent subroutines and decouple their methods and execution from other system components. The functionality that belongs in each component should be defined by that process's data scope, that is, the scope of information that methods residing in a process can act upon and modify. This scope should represent a logical grouping of data that a single task needs to perform a specific set of operations. Strictly adhering to this scope helps to designate where commands should be passed throughout a system and where future functionality should be added. Even if the data scope needs to be increased in the future, it should continue to represent a highly cohesive and logical grouping of data.

As an example, consider a system that can perform multiple asynchronous measurements whose output is then sent via a network to a remote database. The measurements should execute in a separate process from the network communication, and the output of a measurement should be sent to the independent process that is responsible for relaying it to a database. This strict decoupling ensures that measurements can continue to execute as needed without any impact from the latency of network communication. It also makes it possible to swap the database interface for a routine that simply stores results to disk without having to modify the capabilities of a measurement process.

ESTABLISH APIs AND INTERFACES TO SUPPORT FUTURE FUNCTIONALITY

APIs and interfaces for communication with other subroutines and reusable libraries should be clearly established early in development. These interfaces are ideally implemented to support future functionality that may not yet be necessary to minimize the number of changes to the interface. A complementary strategy is to limit the number of subroutines that can talk to one another and use an arbitrator or controller through which the majority of commands must pass. This offers the benefit of isolating interface changes to a minimal number of components, which helps mitigate the risk associated with introducing future changes.

IDENTIFY AREAS THAT NEED TO BE MODIFIED REGULARLY

Arriving at the appropriate architecture requires identifying the stakeholders who will use common components. Will the same system need to be reused across multiple product lines, different organizations, or even external organizations such as contract manufacturers? Which system components need to be modified or extended to cater to these different audiences? Which reusable IP libraries or off-the-shelf software can be leveraged?

The goal of these questions is to define the system areas that will need to be extended and modified on a regular basis and to determine whether the requirements warrant defining abstract interfaces. For test systems, the most common components that need to be extended are the measurement strategies and the hardware that those measurement strategies use. Consider these common examples:

- The same measurement may need to be performed on different test fixtures and hardware resources
- New measurements may need to be added for device capabilities that aren't yet defined
- Hardware may become obsolete and need to be replaced with newer, more performant capabilities

IMPLEMENT A HARDWARE ABSTRACTION LAYER

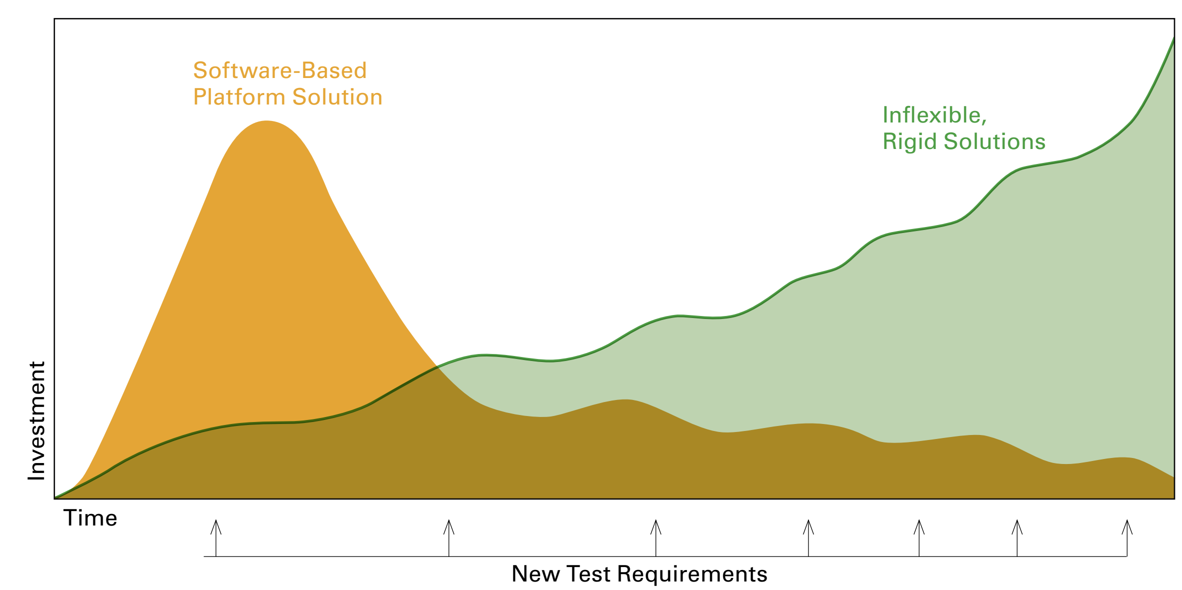
A growing number of test organizations are gravitating toward extensible frameworks that call modules of functionality, or components, that have been developed and built independently of the calling framework. Perhaps the most well-known example of this is a hardware abstraction layer or HAL. A HAL defines an interface for communicating with a specific class of device that can be overridden and updated later without altering previously written and validated code. However, this is only one of many architectures that, when combined, can fully maximize the scalability of a test system.

A HAL implementation ideally caters to the specific requirements of a specific system. Another important HAL benefit is the ease with which recorded data or device simulation can be injected into a system. The same interface that is used to load a new definition of hardware device can be used to call functions that return simulated or recorded data, which makes it easier to continue development when direct access to I/O isn't available.

> We've seen a dramatic decrease in the time, effort, and cost required to develop and maintain some of our most complex test systems by making a considerable investment into people, processes, and software design. We have to deliver and support systems that have long life cycles, so we recognize the criticality of making the necessary investments before diving into implementation.
>
> *Michael S. Flegel, Lab System Team Lead of the National Ignition Facility & Photon Science Directorate, Lawrence Livermore National Security*

EMBRACE AND MANAGE CHANGE

One of the biggest challenges in any complex system is the risk associated with introducing change throughout and especially after the development of a system. Historically, engineers have tried to prevent and even oppose change at all costs; however, market trends make it nearly impossible to avoid change in climates that demand the newest features and the most advanced technology. A more pragmatic approach is to invest in tools, personnel, and processes to identify and understand change and then pair them with robust software architectures, such as HALs, that minimize and isolate the impact of future changes.



With the proper up-front investment in training processes and architecture, the development effort to support new test requirements and functionality is minimized over time, along with the risk and cost of introducing changes to an existing system.

Redefining the Notion of Sensors

Sensors have long been a part of electronic systems in practically every industry. They are so fundamental to the operation of these countless systems that it is hard to imagine life without them. Janusz Bryzek, an executive from Fairchild Semiconductor, says that sensors could reach 1 trillion per year and become 15 percent of the global gross domestic product by 2024.*

For decades, sensors have been used to quantify physical phenomena while serving as catalysts to improved decision making, whether by an engineer or an embedded control system. However, many industries have been forced recently to expand their belief of what a sensor is. As industries continue to adopt the philosophy of more software in embedded controllers and as embedded system electronic complexity grows at an exponential rate, these systems are forced to take input from new devices to enable key features and capabilities. The previous notion that sensors only measure temperature, strain, force, and other basic data points is obsolete. Now engineers consider sensors as including all of these measurements plus technologies like RF signals, images, audio, and video. And test engineering departments face the daunting challenge of developing complete test systems for these complex devices. As market expectations rapidly change, engineers are constantly working to understand new technologies and must adapt just as quickly as their devices under test do.

MORE EXPECTATIONS CREATE MORE CHALLENGES

Some of the clearest examples of this challenge are in high-volume, consumer-facing markets like automotive and telecommunications. In this space, consumers, suppliers, and even legislative bodies have high product expectations.

Consider the automobile. In the past, sensors were used to monitor key data points like engine temperature and oil pressure, but because of the incredible rise in consumer and legislative demands, car manufacturers have been forced to significantly increase their cars' electronic components and capabilities. Today, vehicles are required to control their emissions, correct dangerous human driving behaviors, receive satellite radio signals, and provide a level of entertainment and convenience to passengers. To accomplish all of this, engineers must expand their idea of a "sensor" to parts like O2 sensors for catalytic converter output, cameras for monitoring the driver's eyes, an antenna for picking up satellite radio and navigation signals, and a display for video and information communication.

The mobile phone industry is no different. For example, a mobile phone is projected to have nearly 20 MEMSs/sensors in 2015 compared to two sensors in 2000. The current design of the Samsung Galaxy S4, launched on March 13, 2013, has 10 sensors to detect gestures, proximity, rotation, acceleration, geomagnetic field, temperature, humidity, barometric pressure, and light. This trend in sensor growth has led to new sensor-based "apps," which will continue to drive demand for new sensors in future mobile phone designs. Just like a modern vehicle, the mobile phone continues to evolve quickly, resulting in new types of I/O and physical phenomena being used as "sensors."

IMPLICATIONS FOR TEST

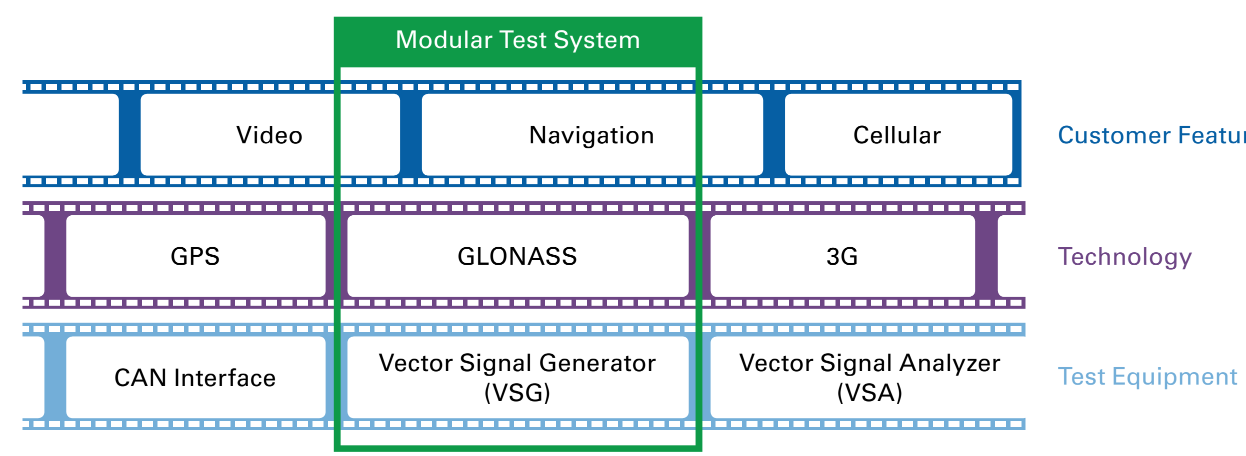
Capital costs of automated testers can account for more than 60 percent of the overall test costs, so minimizing hardware changes can significantly reduce overall costs. For example, a dedicated test solution that addresses mobile devices, which have a typical shelf life of 18 months, has obsolete sensors and technology for every new design. Architecting a test system that can adapt to changes occurring once or twice a year requires an agile or proactive test approach. Unlike an ad hoc approach with dedicated box instruments that specialize in one specific measurement, a proactive test approach features modular hardware and anticipates technology changes. A modular approach minimizes the sustaining cost of a tester with incremental changes instead of whole product replacement.

In addition to a modular test system architecture for adding and removing instruments as needed, engineers require reconfigurable hardware that helps them use the same instrument for different and evolving project requirements. This is evident in automobiles with global navigation satellite system receivers like GPS and GLONASS. If an automotive OEM wants to sell vehicles in the United States and many other parts of the world, the vehicle's navigation system must be able to receive and interpret a GPS signal in all of these locations. The typical test process for these systems is to generate a simulated GPS signal for the vehicle's electronics and analyze how they respond. However, with the continued adoption of different navigation systems, like GLONASS in Russia, these same OEMs must test for multiple navigation signals, depending on the markets they want to penetrate. Having an RF signal generator that they can adapt to simulate both GPS and GLONASS signals helps OEMs get the most out of their capital investment in test systems and helps future proof at least part of their equipment.

A PLATFORM APPROACH FOR RAPIDLY CHANGING TECHNOLOGY

If the vision of a trillion sensors by 2024 is true, product complexity will be growing and changing at a significantly more rapid pace than the current trajectory. This trend will continue to impact test organizations as more frequent product redesigns dramatically affect the total cost of test. Companies that use a test strategy featuring a modular approach that can accommodate the changing sensor market will reduce total cost of ownership and improve redesign time to meet more stringent time-to-market demands.

> In the future, people are going to put sensors in places we never have thought about. The need for sensors is exploding and there are many more potential sensor applications than we could have ever predicted.
>
> *Tom Pierce, Vice President and General Manager, Test and Measurement Business, Honeywell Sensing and Control*



A modular test system provides flexibility to match customer features to the proper technology and the ideal test equipment.

*http://www.edn.com/design/sensors/4423522/Imagining-a-trillion-sensor-world

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