Making the Industrial Internet Real

Highlights of the Intelligent Platforms 2014 User Summit

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CONTROL

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GE BRINGS CONTEXT TO TECHNOLOGY WAVE

Machines and Analytics Are Permanently Connected

by Keith Larson

GE CEO Jeff Immelt delivered three distinct messages in his keynote address to the more than 600 attendees of this week's GE Intelligent Platforms User Summit in Orlando, Florida.

First, every industrial company will soon be a software and data analytics company, or risk competitive irrelevance. Second, because GE is also among the world's largest industrial companies—with some 400 plants and factories and an annual manufacturing spend of $63 billion—it's uniquely qualified to help bring an industrial context to the converging waves of smarter devices, ubiquitous connectivity, big data and analytics washing over industry, a technological tsunami that GE calls the Industrial Internet. Third, even GE can't build out the Industrial Internet on its own; collaboration and co-innovation will be needed to realize its promise.

Clearly, Immelt believes that industry must adapt the Internet to its own needs, even as the need for industrial domain expertise remains front and center. "Machines still matter; but they're surrounded by analytics, by services, by information," Immelt said. Technology will increasingly be embedded in service relationships, and it has to be linked to customer outcomes. "An oil and gas company CEO will listen to me talk about helping him eliminate unplanned downtime, but talk about the Industrial Internet, and he'll throw me out," he joked.

As an enabler of business outcomes, however, "the Industrial Internet is real—it's not a cartoon, and it's not Powerpoint," Immelt stressed. Companies that can harness the triple potential of smarter machines; the enabling power of sensors, services and connectivity; and industrial big data and analytics can help themselves (and their customers) optimize assets, optimize operations and realize the power of "the one percent." The power of the one percent is GE shorthand for incremental improvements that pay off big. For example, a 1% improvement in fuel efficiency of the global airline fleet is worth $3 billion. "Small changes can be worth tens of billions of dollars," Immelt said.

"Machines and analytics are permanently connected," Immelt concluded, "and industrial companies must change to seize the next wave of productivity. Together we can build this capability, industry to industry." ■

"Machines still matter." GE's Jeff Immelt on the continued importance of big iron, even in the age of big data and the Industrial Internet.

ZERO UNPLANNED DOWNTIME CLEARED FOR TAKEOFF

Delta Air Lines Uses Predictive Analytics Software to Keep Aircraft in the Sky Where They're Profitable

by Mike Bacidore

Jeff Slagle is known as the grim reaper of engine maintenance. If he's coming to talk with you about an aircraft engine, the news is typically not good. Slagle joined Delta Air Lines in 1998, testing engines, and is now the general manager of propulsion engineering.

"Nobody wants to be on an aircraft that's delayed by six hours," said Slagle, who spoke today about Delta's journey toward zero unplanned downtime at the GE Intelligent Platforms 2014 User Summit in Orlando, Florida. "Aircraft are made to fly, and we're reminded of that every day. We want to address the minor issues before they become major issues. One delay or cancellation can have a cascading effect on the entire operation. We learn from the past, and we're committed not to repeat it."

Delta's 80,000 global employees are dedicated to ensuring that its 5,400 daily flights are on time to more than 300 destinations on six continents. And with approximately 700 mainline aircraft in service at any given time, they generate a lot of data that can be monitored and analyzed to keep aircraft in the sky. "One of the major costs at Delta is aircraft downtime," said Slagle. "We want to know what the aircraft is doing and what the engine is doing. We want to do maintenance on our terms. We were an original customer of SmartSignal, and we've evolved to where we are today with the GE Intelligent Platforms Proficy platform. Complexity drives change. A complex network demands efficiency. And technology has to play a major part in what we do. An aircraft out of service in Shanghai or Dubai is different from an aircraft out of service in Memphis. We want aircraft out of service where we can work on them."

Minimizing aircraft downtime is a competitive advantage for Delta, and the software's ability to standardize analytics across multiple assets from varied suppliers is a major reason why Delta has continued with it after the company's acquisition by GE and integration into the

"We no longer allow what has happened in the past to determine how we address the future." Delta Air Lines' Jeff Slagle discussed how the carrier has used GE SmartSignal technology to more than cut in half the number of aircraft sidelined unexpectedly.

Proficy platform. Although the majority of Delta's aircraft engines are from GE—namely the GE90, CF6 and CFM56—its global fleet operates 14 different engine configurations, including assets from International Aero, Rolls Royce and Pratt & Whitney. "If we used the OEM solutions for monitoring, we'd need five or six different platforms," said Slagle.

One standardized platform can enable efficiencies, but what is the business value of being a data-driven operation? "We no longer allow what has happened in the past to determine how we address the future," said Slagle. "You have to dig in to the data and understand what it's telling you. We have a team of seven data analysts and a manager. Every day, our aircraft are talking to us. The aircraft wirelessly transmit data for takeoff, climb and cruise, along with the engine data. It's our job to interpret the data and act on it. Too much data can be annoying noise, and we have to determine where to focus our attention. You can't listen to 700 aircraft a day. You have to know how to identify the squeaky wheel and then listen to it."

Delta traditionally used worm charts to visualize data and then plot it against previous data from the same asset. "You're looking for variation to determine whether you have to act on it," said Slagle. "It's a very laborious chore. That's how we originally started using SmartSignal, which was a small company with little or no aviation experience at the time. With SmartSignal, we could use predictive analytics and do maintenance on our terms."

Just before GE's acquisition of SmartSignal, Delta merged with Northwest Airlines. "That led us to Proficy SmartSignal Sentinel," said Slagle. "I wanted the ability to monitor the GE and the Pratt fleet so it all looked the same. We could use the long-standing OEM rules for alerts and create new rules. We started out with the legacy Delta fleets and then moved to the Northwest fleets."

In the past, it wasn't uncommon for Delta to have 20 unplanned out-of-service aircraft, but that number already has dwindled to about seven per day. "Having a dozen more planes available helps cancel out those down-line cascading cancellations. We want to be able to use engine condition monitoring to dispatch parts and have aircraft repaired without any interruption to service," said Slagle. An additional benefit includes using the software for asset lifecycle management. "Green time is the amount of usable time left on the engine," he explained. "We're using the program to determine the life of the engine on wing. Nobody likes to pull an engine off-wing early." ■

INDUSTRIAL INTERNET AIDS WATER/WASTEWATER—AND COWS

Greater Cincinnati Water Works and Zoetis Find Their Paths to the Industrial Internet Through the Cloud

by Jim Montague

Now that it's approaching critical mass in mainstream understanding and usefulness, the Industrial Internet is quickly being adopted in an ever-expanding number and range of applications.

For instance, the Greater Cincinnati Water Works (GCWW) and Metropolitan Sewer Dept. are employing the Industrial Internet and solutions from GE Intelligent Platforms to improve its resilience and speed up its response to storms and overflow conditions, while animal pharmaceutical supplier Zoetis is using radio frequency identification (RFID) and the Industrial Internet to help improve diagnosis and medical care of cows in feedlots.

"The Industrial Internet is real, and this is good because 70% of the world's people will be living in cities by 2050," said Bijou George, deputy director of GCWW. "Fortunately, advanced information and communications via the Industrial Internet can help address these trends and help make cities more livable and sustainable."

George and Stuart Fisher, associate director of strategic initiatives at Zoetis, presented "The Industrial Internet at Work" on the first day of GE Intelligent Platforms 2014 User Summit in Orlando, Florida.

The challenge in Cincinnati is that it now has abut 1,000 miles of combined sewer operation (CSO) lines, which must also handle the 41 inches of rain that the city gets each year. In all, GCWW manages 75 billion gallons of sanitary flow per year, plus another 25 billion gallons of rainwater, which jointly result in about 11.5 billion gallons of annual overflow. Besides supplying water to Cincinnati's 78 square miles, GCWW also supplies water to communities in a neighboring 840 square miles, including some parts of Kentucky.

Similar to many U.S. water/wastewater systems, Cincinnati implemented a geographical information system (GIS) and sensors in the 1990s, and these capabilities were upgraded following the Sept. 11 attack in 2001. Presently, it's also leveraging several cloud-computing

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"The Industrial Internet is real, and this is good because 70% of the world's people will be living in cities by 2050." Greater Cincinnati Water Works' Bijou George explained how his organization is using GE Proficy and SmartSignal technology to improve its resilience and speed up its response to storms and overflow conditions.

technologies and is even allowing its data to be hosted on a secure, cloud-based service. This is especially helpful because performance data at GCWW is coming in from new sources. The utility is even using satellite images to determine parts-per-billion phosphorus levels in its surface water. George added that GCWW also integrates data from its own pipelines, pumps, 90,000 manhole-based indicators and other equipment with information from other sources, such as the National Oceanographic and Atmospheric Administration, river level gauges and other components.

"Cloud computing and using GE Proficy and SmartSignal software hosted on a third-party, cloud-based infrastructure is a lot better than keeping the data in our own facilities because we can fuse together our data from different GCWW locations and applications and make decisions much faster and closer to real-time than the two or three weeks that simulations used to take," explained George. "Faster decisions also mean we can maximize the performance of our wastewater and water production systems, decide to move or hold pumps sooner, and reduce the effects of overflow situations.

"Now our system is optimized for water quality and reduced energy costs, and we're more resilient and sustainable. We're also seeing the value in asset optimization by using predictive analytics. In the future, I think we're going to have more autonomous processes and use more collaboration platforms enabled by the Industrial Internet."

Fisher reports that Zoetis, which is likewise concerned with serving large populations, was spun off from Pfizer in 2013 and manufactures about 300 different pharmaceuticals for cats, dogs, cows, pigs and other animals. To help cowboys find and care for sick cows in their feed lots, Zoetis recently developed a technical method for identifying ailing animals.

"The cattle-feeding industry has been affected by recent droughts that have pushed costs up. Also, there's a big labor shortage because today's cowboys are more reluctant to be out in the elements," explained Fisher. "There are usually about 100 cows, and they require attention and care, including medication. Usually, the cowboys manually see which cows' heads may be drooping or if they're on the ground. These or other conditions may indicate that they're sick and need to be pulled out and sent to a hospital pen."

Consequently, GE Intelligent Platforms, Zoetis and its users developed a solution that combines RFID tags and GE's Proficy platform to help show which cows might be ill. This solution recently completed six months of early testing at a feed-yard operation in southwest Kansas.

We were happy to find that, where the cowboys might pull about 115 to 128 cows for morbidity issues, the new technical solution only needed to pull 60 cows for morbidity issues, which was a 50% reduction," says Fisher. "Also, when two or three pulls were needed to treat cows a second and third time, our technical solution reduced pulls by 74% on second pulls and by 82% on third pulls. This means better health and performance for the animals and better economic results, including 8% better average daily weight gain and improved dry-matter conversion from feed to weight on the animals." ■

VIRTUALIZATION COMING SOON TO A CONTROLLER NEAR YOU

Partitioning, Para-Virtualization Allow Implementation of Mixed Criticality Systems

by Keith Larson

Just as virtualization technology transformed the IT landscape and crept into the supervisory and execution layers of many a manufacturing facility, it's now poised to invade real-time controls, too. "The technology is inevitable, and it's coming sooner than you think," said Rich Carpenter, chief technology strategist for GE Intelligent Platforms, in his presentation "Virtualization of Control in the Era of Software-Designed Machines" today at the company's User Summit in Orlando, Florida.

In making his case that the time for embedded virtualization has arrived, Carpenter pointed to other examples of systems that already mix critical and noncritical functionality. "Today's cars will brake for you and park for you, yet play your favorite music too," Carpenter noted. As in the automation industry, "this integration of critical and noncritical systems is driven by the desire to deliver new services and functionality."

The move to embedded virtualization comes even as platform providers shift to increasingly powerful multi-core, multi-threaded systems. Indeed, multi-core systems are tailor-made for performing multiple simultaneous tasks; what makes them appropriate for industrial control is the ability to provide strong partitioning between critical and noncritical applications, according to Carpenter.

"For control system virtualization, you need to preserve the integrity of highly integrated architectures, yet allow noncritical functions to co-exist," explained Carpenter. "The cost of entry is strong isolation of these applications." This means that real-time controls and other functionality need to be partitioned in spatial, temporal and fault dimensions. In short, this means physically separated computing resources to ensure that timing constraints are met, and preventing faults in noncritical applications from intruding upon the operation of critical ones.

Effective isolation, in turn, entails the

"For control system virtualization, you need to preserve the integrity of highly integrated architectures, yet allow noncritical functions to co-exist." GE's Rich Carpenter described how effective partitioning is necessary to effectively manage virtualization of control layer applications.

use of “type 1” hypervisors that give critical applications direct, “bare metal” access to dedicated computing, memory and I/O resources, while simultaneously providing a more traditional virtualization layer beneath the noncritical applications. A hypervisor is the virtualization layer that effectively abstracts guest applications and operating systems from hardware implementation details.

A type 1 hypervisor setup also is referred to as para-virtualization. “With full virtualization using a type 2 hypervisor, none of the guest applications even know that they are hosted,” Carpenter explained, “whereas with para-virtualization, the real-time operating system (RTOS) is modified to take advantage of direct hardware access through the hypervisor. Para-virtualization fits with mixed criticality systems.”

To take full advantage of the potential benefits of virtualization at the control layer, available configuration and management tools have some catching up to do, Carpenter said. Ideally, an integrated design environment would allow one to manage the hypervisor, operating systems and virtual machines, as well as the partitioning of physical resources. The tools also need to be able to validate nonfunctional requirements such as time, safety and security, provide support for legacy applications, and support deployed systems once they’re out in the field. “The goal is to move from design to certification to design for certification, to use pre-qualified components in a way that doesn’t affect system behavior,” Carpenter said.

Carpenter admitted that virtualization of control is initially a bit much to wrap one’s head around, but once you do, “the sky’s the limit. A lot of things are possible with this kind of system.” Carpenter went on to describe an Industrial Internet Edge Node, a single box that would include traditional PLC functionality—with partitioned RTOS, controller virtual machine and Profinet/OPC UA control network interface—together with fully virtualized applications and associated operating systems for cloud access and HMI. An advanced process control application also could be implemented alongside the other applications. “Virtualization has proven economic benefits,” Carpenter said. “We’re seeing this as a natural progression of control.” ■

CLOUD APPROACH SPEEDS APPLICATION DEPLOYMENT

AkzoNobel, TempuTech Get Up and Running More Quickly with Cloud-Based Applications from GE Intelligent Platforms

by Jim Montague

The eternal goal is still better, safer, more efficient and profitable operating decisions. And for a chemical manufacturer and a grain-handling OEM who spoke today at the GE Intelligent Platforms User Summit, the latest, fastest way to get there is cloud-based data gathering, storage and analysis using GE software, equipment and services.

Two GE customers, AkzoNobel and TempuTech, described their experiences and best practices for accessing and using the cloud in their respective chemical manufacturing and grain handling applications during sequential presentations themed "Cloud Computing Becomes a Disruptive Business Tactic."

Stefan Malmsten, global industrial IT leader at AkzoNobel, reported that his company uses remote monitoring and operations to bring it even closer to its end users and customers. Its chemical manufacturing division just rolled out a manufacturing execution system (MES) to 30 remote plants in only 12 months—and relied on cloud services and GE Intelligent Platforms to do it successfully.

Even though it's more than 350 years old, AkzoNobel just finished its second year leading the Dow Jones Sustainability Index. It's also a €14.6-billion company with 49,600 employees at more than 200 production sites in 80 countries. Malmsten added that the specialty chemicals division where it's implementing cloud-enabled MES "delivers leading performance based on sustainable chemical platforms driving profitable growth in selected markets," and it also relies on social media-based networking by its personnel.

"We maintain a social manufacturing network worldwide that enables both our people and their devices to interact with each other, and we're building solutions that let them talk about important things and share best practices, especially over long distances," said Malmsten. "We started bringing people together using

"These cloud-based tools give us numerous benefits, including reduced production and delivery expenses." AkzoNobel's Stefan Malmsten on the company's ambitious roll-out of cloud-based MES applications to 30 plants in only 12 months.

remote technologies in 2000. We use a lot of GE's Proficy software, so we've gained a lot of experience over that time. Now our MES and private cloud server is in Amsterdam, so it's our responsibility to take ownership of the applications we provide to our users. This is a very sound way they can all be more competitive, but they needed common language among people at different sites."

Consequently, AkzoNobel worked with GE Intelligent Platforms and its Proficy software, along with solutions from Accenture and SAP, to develop its Enterprise Process Information (epi) Connected program, which also has been implemented at more than 100 customer sites. The program now includes some 2,000 global users and handles billions of daily data transactions.

"Working with an external partner, we host epi on one central server," explained Malmsten. "This is much simpler than the four or five servers per site that we used to have to handle. With two or three clicks, we can move from a chemical manufacturing plant in Canada to a paper factory in Italy. With epi, we can examine their supply, production, distribution and usage steps."

Likewise, Malmsten reported that AkzoNobel even uses epi and the cloud to help run a partially unmanned hydrogen peroxide plant in Norway from its office in Sweden about 500 kilometers away. "This plant runs 24/7, but we only have staff there on weekdays," said Malmsten. "They run and prepare operations, and then it runs unmanned on nights and weekends. It's been doing this for more than 10 years, but we can still deploy experts when needed."

Finally, because it used a global MES template for the roll-out to 30 facilities initially, AkzoNobel is planning to add another 10 sites this coming year. "These cloud-based tools give us numerous benefits, including reduced production and delivery expenses, and also lessen the costs of using our products," added Malmsten. "However, all these efforts start and stop with having the right people."

Similarly, to optimize its grain management and hazard monitoring solutions, TempuTech is embracing the cloud to improve existing operations and go after new markets, according to Adrian Merrill, operations vice president at TempuTech. Its grain management equipment includes temperature and moisture sensors to monitor stored grain and create reports, while its hazard monitoring devices capture data from conveyor systems, alerting operators about potential hazards. It also makes a variety of cabling, software and turnkey facilities for large and small grain facilities, and employs GE Intelligent Platforms' RXI PLCs.

"The challenge with previous solutions was that data was only gathered and presented daily, so it wasn't anywhere close to real time. Plus, these old methods were costly, hard to maintain and hard to access because they were only available onsite and required dedicated workstations," said Merrill. "In 2009, we were still a break-and-fix company. We needed to get real-time information to any users on their mobile devices."

As a result, TempuTech decided to implement GE's Equipment Insight software. TempuTech first tested Equipment Insight in two units at Riceland Foods' rice processing facility in Jonesboro, Arkansas. One unit had six bucket elevators and six feeder conveyors, and the other had 10 bucket elevators and 10 feeder conveyors. All together, the operations account for almost 300 sensor points. Proof of concept was performed in February 2014, and field testing was done in May 2014.

"Now we're in the third stage, which is getting our grain management even more into the cloud," added Merrill. "This includes redesigning our switchbox, incorporating GE's RXI I/O island and embedding wireless fan controls as needed. The benefits will be elimination of thousands of feet of control wire; isolation of each section of up to 30 cables; easier and faster installation; better real-time data sources; and remote alerts."

"These cloud-based solutions mean added revenue because users can determine which of thousands of bearings need grease or which belts are out of alignment before the usual alarms go off. In fact, Riceland is already talking about adding Equipment Insight at two more facilities. So we recommend not being afraid of the cloud. Just define and refine your project scope; plan for a learning curve; don't fall prey to naysayers; and educate up to management and down to operators." ■

MANUFACTURING IN A WORLD OF PERVASIVE DATA

The Brilliant Factory Is Fast, Virtual and Rife with Culture-Change Demands

by Mike Bacidore

The GE Brilliant Factory vision is based on creating a "digital thread," a data supply chain that runs from a product's conception through design, to the field and back again (for repair, recycling or remanufacturing) in a closed-loop process. "The biggest challenge in connecting to the digital thread is culture," said Paul Boris, CIO — advanced manufacturing strategy at GE. "People need to think differently about these approaches and how you can drive progress from the middle, even if you're not the CEO of your organization."

Boris is also leader of GE's Advanced Manufacturing and Software Technology Center in Detroit, and he explained how data and technology will affect the future of manufacturing in his keynote address at the GE Intelligent Platforms 2014 User Summit in Orlando, Florida. "I can see a time when we put a factory in a container and ship it somewhere," he said. "Machines will be coming in equipped with sensors and ready to plug in to the business."

Manufacturing continues to evolve, Boris said. Hardware is converging with software, creating a new class of innovators and entrepreneurs enabled by 3D printing, desktop design and virtual manufacturing. "We've got to stop thinking about making things just a little bit better," said Boris. "We have to think in terms of a vision that's way out—a moonshot—and then bring it back to where we can accomplish it one piece at a time." The capacity to innovate today is much greater, with faster prototyping and more creative collaborations. "But we still have to make stuff and ship it. You can be as theoretical as you want, but you'll be theorizing on your way to the recruiter if you don't get product shipped. There needs to be democratization of global and distributed manufacturing. This means engaging more innovators and showing everyone what's manufacturable and building products earlier."

The Brilliant Factory concept is intended to allow manufacturers to drive the data supply chain and make adjustments more quickly. "Think of the physical supply chain, and think of what most of us do in a manufacturing plant," advised Boris. "I shouldn't need to know or care how the data flows. It should be pervasive. The physical and digital worlds are converging, not colliding. A collaborative mentality drives the best ideas faster. We have to develop a bigger vision and collaborate across teams."

"You can be as theoretical as you want, but you'll be theorizing on the way to the recruiter if you don't get product shipped." GE's Paul Boris on how advancing technology and data supply chains are changing the face of manufacturing in ways small and large.

With hundreds of 3D printing machines across the company, GE already is using them to develop parts for aviation, oil and gas, healthcare, power and water. “GE is also a huge customer of GE” Boris reminded the audience. “We call it industry for industry. We have a fairly complex array of businesses. But how do we alter the marketplace and deliver differently for the end customer? How do we look at problems fundamentally differently? Technology is a tool or enabler to drive change, and we see a huge opportunity to team up to drive the change. If you can’t break down the divide between information technology and operational technology, you have very little chance of taking advantage of new capabilities and driving change in the marketplace.”

Boris recalled his resistance to upgrade to Windows years ago because he didn’t want to pay $1,000 for 1 MB of RAM. “The next generation is not bounded by things that I’m bound by,” he explained. “In emerging markets, they don’t put a business plan together to put up telephone poles and string wire or set up bank accounts. They get a 4G phone, bring a cart of product into a store, and the digital transaction is handled via smartphone by the telecomm provider. This is a moonshot. It’s doing things completely differently.” ■

SOFTWARE SUITE COMBINES GE HISTORIAN, DATA ANALYSIS SOLUTIONS

GE Releases and Features Its Proficy Monitoring & Analysis Suite (PMAS) at This Year’s Summit

by Keith Larson

Today at its Intelligent Platforms User Summit in Orlando, Florida, GE announced the release of a new version of the Proficy Monitoring & Analysis Suite (PMAS) that integrates its industrial data historian, Proficy Historian, with its advanced analytics capabilities, Proficy SmartSignal. The new offering also uses GE’s Predix platform for the Industrial Internet.

PMAS is an end-to-end solution that uses Proficy Historian to collect, organize, store, visualize and analyze data, and Advanced Analytics software based on Proficy SmartSignal to improve both asset health and process performance by providing the earliest detection of emerging equipment failure, often weeks to months ahead of other technologies.

“The Industrial Internet is all about intelligent machines, advanced analytics and people at work, coming together to solve problems as never before,” said Brian Courtney, general manager of GE’s Industrial Data Intelligence product group. “It’s about gathering much more data, industrial big data, more efficiently and over longer periods of time, and using advanced analytics to interpret this data in more meaningful ways. PMAS brings this to life to help customers collect, organize and analyze equipment and process data to maximize productive output and lower operating costs, with fast payback and low risk.”

Because it is fully integrated, PMAS reduces implementation costs and time-to-benefit. And because it has been proven through years of use in GE monitoring centers, it reduces risk. In addition, GE offers full implementation, monitoring and maintenances services from GE equipment and software experts so PMAS can be used by any company, regardless of level of IT and engineering expertise.

PMAS component technologies include Proficy Historian, a distributed architecture historian that features central management and administration, low storage costs and a wide range of industry-standard interfaces. Proven through tens of thousands of installs around the world, storing hundreds of millions of tags of information, Historian provides the backbone of PMAS. Historian is scalable from embedded

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technology in control and SCADA layers, to site and enterprise scale with Distributed Historian Services, to a cloud-based Industrial Big Data solution based on Hadoop technologies. The software improves performance by handling data sampling down to the micro-second and storing full-fidelity data 85% more efficiently than standard relational databases. And its built-in compression algorithms reduce the cost of storage.

PMAS offers two types of advanced analytics capabilities—Asset Analytics to improve asset health and Process Analytics to improve and optimize processes. Proficy SmartSignal improves asset health by providing the earliest detection of emerging equipment failure. This patent-protected software helps detect and fix emerging issues before they become large problems. SmartSignal helps avoid catastrophic equipment failure, process upsets and unplanned outages—and is intended to help approach zero unplanned downtime.

With SmartSignal, users can maximize revenue by improving reliability and availability, reduce maintenance costs by replacing reactive maintenance with less expensive proactive maintenance, reduce maintenance frequency and duration by fixing only the equipment that needs to be fixed, reduce replacement costs by ordering parts at notification of an impending problem, not later during an emergency, extend asset life by fixing problems before they get serious, and even reduce energy costs by running equipment more efficiently. SmartSignal works on any equipment from any OEM in any service on any piece of equipment that's critical to production.

GE's Process Analytics software, Proficy CSense, provides deeper insight on process performance. It improves and optimizes processes by providing powerful analytical tools that use leading-edge techniques to extract knowledge from existing historical process and manufacturing plant data. CSense helps to identify causes for production problems, along with opportunities for preventing these problems in the future. This software can be used for batch and discrete processes, as well as continuous processes and helps to increase yield, while reducing variability.

Located outside of Chicago, GE's Industrial Performance & Reliability Center (IPRC) provides full monitoring services to customers who have constrained resources, but need to avoid catastrophic equipment failure, process upsets, unplanned outages and unplanned downtime. The IPRC uses PMAS software along with deep subject-matter expertise to provide predictive diagnostic advisories on emerging equipment and process problems. The IPRC currently monitors more than 5,500 assets globally for customers in the power generation, oil & gas, mining and aviation industries.

PMAS seamlessly integrates the cases generated by the IPRC with onsite data in Proficy Knowledge Center (PKC). PKC provides asset-centric views for an entire fleet of assets. It connects the predictive-analytic cases with onsite tools that allow users to build standard diagnostic procedures in order to institutionalize the processes around diagnostics for industrial equipment failures. This standardization reduces time-to-diagnose, ensures consistency in execution and provides a mechanism to institutionalize diagnostic knowledge into a stepwise procedure that even novices can support.

"The real power and uniqueness of PMAS is its ability to provide the ability to foresee asset failures months before they become major issues." GE's Brian Courtney on the release of the company's Proficy Monitoring & Analysis Suite 2.0.

"The real power and uniqueness of PMAS is its ability to provide the ability to foresee asset failures months before they become major issues with the insight tools needed to diagnose the root cause of failures in time to take action," continued Courtney. "This allows users to perform timely and cost-effective maintenance action. It also allows customers to institutionalize knowledge to create standard diagnostic procedures to drive learning and consistency, ensuring they capture best practices for timely action." ■

BACK TO THE FUTURE OF BIG-DATA ANALYTICS

The Industrial Internet Maturity Model Gauges Where You Are on the Connection-Optimization Curve

by Mike Bacidore

In 2015, a teenager will be able to make a quick escape from trouble on his very own hoverboard, a wheel-less skateboard that flies three inches off the ground. Of course, that is the fictional world where Marty McFly finds himself in the 1980s movie franchise, "Back to the Future." But, as Kate Johnson, GE's vice president and commercial officer for sales and marketing points out, "There's a hoverboard that works now. The future is here. Marty McFly's futuristic world of 2015 is just months away."

Johnson capped off a day of presentations on the Industrial Internet and big-data analytics at the GE Intelligent Platforms 2014 User Summit in Orlando, Florida. "There's a massive transformation that the Industrial Internet is having on our company and our customers. We're talking about leveraging big-data analytics. The future that we see is one with no unplanned downtime. That's the holy grail. That future is right on the horizon. It's going to go lightning fast," she predicted.

When the consumer Internet exploded and a billion people came online, everything changed, and the companies that leaned into it became mighty, said Johnson, citing the likes of Amazon and Google. "When 50 billion machines come online, everything's going to change again, and this time it's going to be faster because we already know how to do this," she explained. "The pace of innovation is changing. It's knowledge at the speed of thought. GE wants to lead and be on the mighty side. We've had to change some big things to take advantage of this opportunity."

The holy grail of no unplanned downtime is just the nose of the hoverboard in terms of what big-data analytics can do. Add better reliability, better availability, lower risk and lower fuel costs to the list of benefits, and you don't need a flux capacitor to envision a futuristic world where data enables better business decisions and more profitable customer outcomes.

GE's internal transformation encompasses a focus on customer outcomes, as well as a push to leverage

"When 50 billion machines come online, everything's going to change again." GE's Kate Johnson on the coming transformation of the industrial landscape.

big-data analytics and a new style of customer engagement, explained Johnson. “What does it mean to leverage big-data analytics?” she asked. “To leverage it across our company, we had to build a platform, Predix, to drive the pace of innovation ever faster. Just like the open-source world of technology, the pace of innovation is taking off. Big-data analytic software development will go through the roof because of the Predix software development platform. We’re borrowing best practices from Proficy, and vice versa. Over time, you’ll see the unification of Proficy and Predix.” And customer engagement will now entail making hardware, software and services available to customers, she explained, eliminating the borders between those three groups from a customer perspective, despite each group having its own P&L.

“Fifty billion machines will be connected on the Internet by 2020,” said Johnson. “At GE, we have 10 million sensors collecting 50 million data elements, and we have $20 billion of potential annual customer savings in our line of sight. For example, one of our oil-and-gas customers is off the coast of Scotland with $6 billion in assets under management.

We found something wrong with a seal on the water-injection machine by looking at the data. The data showed that there was a failure pending, and we recommended they swap out the part in the next maintenance window. They didn’t have a spare on the rig. They saved about $7.5 million in outage time because they were able to swap it out before it failed. When they took it out, they confirmed it was going to fail.”

Another customer, e.on, was able to realize a 4% increase in power output across 283 wind turbines, thanks to analytics. “We were able to put together hardware, software and service to provide a platform,” said Johnson. “That 4% increase is equivalent to 20 new turbines.”

All of these customers want a world where they can understand their operations completely and want them to be thrillingly predictable, said Johnson.

To get there, Johnson recommends a three-step plan.

- Know where you stand.
- Set a goal and make a plan.
- Pick the right partners.

Asset performance management (APM) has a major impact on enterprise value, and it can be tracked with an adoption curve called the Industrial Internet Maturity Model, which assesses the capabilities that customers have to manage assets. The first step on the curve is connecting to machines. Once connected, the machine conditions can be monitored. The data that’s collected via monitoring then can be analyzed. That analysis enables predictability. And then, once you’re on the final point of the curve, you are optimizing assets to eliminate unplanned downtime—the holy grail. ■

SOFTWARE AT THE HEART OF THE INDUSTRIAL INTERNET

Two Award-Winning Innovations Complement a Strategic Partnership.

by Mike Bacidore

This could be the start of something big. “Over my career, I’ve witnessed three or four major shifts in automation,” began Bernie Anger, general manager of GE Intelligent Platforms, who kicked off the second day of the company’s 2014 User Summit in Orlando, Florida. “Right now, we’re witnessing the next huge wave of change and innovation. This wave of Industrial Internet and cloud-assisted automation is as big as HMIs and PLCs were.”

“Hardware matters, but it matters differently than it did in the past. Hardware is the edge of the Industrial Internet,” he said. Software, meanwhile, is at its core. The new software, computing and communications capability now available mean that “every notion we’ve had about how much something costs and how long it takes to do it are absolutely false,” he said. “We want you to think of GE as the leader in the off-the-shelf software that makes it all possible.”

Anger’s words rang especially true on a day that also marked some noteworthy announcements from GE. These included two award-winning innovations, one a workflow implementation that works with Google Glass and the other its exida-certified safety management system, as well as a partnership with Webalo to enable mobile intelligence.

Novotek, the largest European distributor for GE’s Intelligent Platforms business, was awarded the Scanautomatic Prize for Innovation at Scanautomatic 2014 in Gothenburg, Sweden. The innovation, which combines GE’s electronic work instructions with the Google Glass wearable computing device, is being demonstrated to User Summit attendees in the Technology Fair.

A work process management solution, GE’s Proficy Workflow software provides users with interactive, step-by-step task instructions and captures process, traceability and quality data across systems to reduce errors, waste and delays. At Scanautomatic, Novotek combined Workflow with Google Glass for hands-free, expert guidance through process steps. Visitors could try the

“Every notion we’ve had about how much something costs and how long it takes to do it are absolutely false.” GE’s Bernie Anger believes that whether we realize it or not, the Industrial Internet and cloud computing have already turned the economics of automation on its head.

innovation by building a Lego car, with all of the instructions displayed in the Google Glass glasses. They could keep both hands available to complete task steps with instructions presented directly in front of them.

"By combining Proficy Workflow with Google Glass, this innovative solution from Novotek allows operators to get to a new level of ease-of-use and expertise that can be extended to industrial applications," said Matthew Wells, general manager of automation software for GE's Intelligent Platforms business. "By getting the work instructions directly on Google Glass glasses, the user always has the right information at the right time and can perform operations with the support of electronic work instructions, helping to ensure that every process step is completed correctly, with automatic tracking and analysis for improvement. This is truly the next generation of interactive work tools."

Meanwhile, GE's Mark VIeS Safety Management System received the exida 2014 Safety Award in the Logic Solver category. "To help meet the ever-evolving safety challenges of today's connected world, GE has leveraged its rich history of critical process control to deliver the Mark VIeS Safety Management System," said Steve Close, exida senior safety engineer. "We feel as though the Mark VIeS Safety Management System best demonstrates exceptional work and has the ability to play a key role in the continuous journey of making the world a safer place."

Exida, which provides functional safety and cybersecurity certification for the process industries, presented awards in three categories: Sensor, Logic Solver, and Interface Module. "Exida has certified many logic solvers," said Dr. William Goble, CFSE, principal partner at exida. "The GE Mark VIeS Safety Management system has very flexible redundancy architectures. This feature, as well as several others, made this product stand out amongst the 2014 Safety Award nominees."

The Mark VIeS system is a complete, flexible and reliable engineered process safety system with enhanced cybersecurity for critical processes such as plant emergency shutdown, burner management, critical process control, fire and gas detection, and turbo machinery safety. Part of the Mark VIe family of integrated control and power conversion solutions, Mark VIeS boasts SIL3 fault tolerance, triple modular redundancy (TMR) and an end-to-end architecture that optimizes assets and operations, as well as reduces costs.

GE also announced a partnership with Webalo to mobilize business intelligence combined with operational awareness and enabled by the Industrial Internet. Proficy Scorecard, built on Webalo's secure, scalable, high-productivity mobile app development platform, Webalo Pro Appliance, and GE's Proficy Mobile, generates real-time views of information, from multiple data sources within the company to provide actionable "scorecards" for all departments in an organization.

Proficy Scorecard is enabled by GE's Proficy Mobile solution, which allows industrial environments of all kinds to provide engineers, on their desktop or on a mobile tablet computer or smartphone, with real-time information about the state of operations. With Proficy Scorecard views in hand, engineers can then make the connection between business intelligence and operations. Because it is mobile, critical data helps users to monitor the KPIs the business cares most about while drilling down to the operational details and making the Industrial Internet real in the company.

"Proficy Scorecard is a very productive, high-value, use of Webalo," said Peter Price, CEO of Webalo. "It delivers a panoramic view of the enterprise that is tied to real-time data and provides employees with the exact information they need to maintain the highest levels of productivity."

Using Proficy Scorecard companies can combine data from Proficy with other enterprise applications that the business relies on, including ERP systems or in-house custom-built applications. ■

LEADERSHIP ENABLES RIGHT DECISIONS ON SEA AND IN OIL FIELDS

Military Skills Translate to Oil and Gas Extraction

by Jim Montague

The differences between operating a U.S. Navy aircraft carrier group and a partnership between GE and Chevron to recover oil and gas are more than skin deep. However, they also have many data, communications and performance needs in common, so the skills and leadership needed to accomplish both successfully are also very similar.

"It's all about getting the right information to the right people at the right time, so they can make the best decisions possible, and this capability is as important in process applications and manufacturing in this high-tech age as it is in military operations worldwide," said Ron Reis, senior service manager for North America at GE Oil & Gas.

Reis is uniquely qualified to convey this lesson because, until 18 months ago, he was the commanding officer of the $8-billion U.S.S. John C. Stennis nuclear aircraft carrier and its 5,000-member crew, and he led and supported combat operations in two deployments. The carrier has 70 strike aircraft, two 550-MW nuclear reactors, 280,000 shaft horsepower and four propellers. During his 28-year military career, Reis also flew 100 combat missions over Iraq and Afghanistan. He described his experiences and their applicability to the process industries in his presentation, "Leadership and the Industrial Internet" on the second day of GE Intelligent Platforms 2014 Users Summit in Orlando, Florida.

"Technical leadership and persistent intelligence affects operations, so it's important to enable leadership at all levels to accomplish missions, whether they were part of my naval experience or related to how GE unlocks the language of machines to partner with customers to accelerate the power of the Industrial Internet," said Reis.

The former captain added that his carrier's operations often occurred in the multi-threat, multi-mission environment of the Persian Gulf, where one of the main tasks is to keep the sea lanes in the small and congested Straight of Hormuz open and safe for

"These wells have been producing oil, gas and water for many years, and now this partnership is using microwave and Doppler radar to determine the temperature, pressure and other conditions in the reservoirs." GE's Ron Reis on the similarities between military organizations and the oil and gas industry.

ship traffic. The difficulty is that the carrier and the support ships in its strike group must monitor conditions and possible threats on and below the sea, in the air, on land and even from space and now, cyberspace.

"All of the information from the sensors on the group's ships and aircraft are sent to the carrier's combat information center (CIC), where all of this data is gathered and analyzed to help the bridge make critical decisions," explains Reis. "The drawback is that the U.S.S. Stennis was engineered in the 1970s and built in 1995, so we were also living with 20th-century infrastructure, while operating in a 21st-century world, and found we weren't capitalizing on what we needed to do."

Reis wanted to empower his high-level officers to make more tactical decisions, but found they were constrained by some communication and cybersecurity issues. Consequently, Reis and his staff leveraged existing and available technologies over a four-month period and developed much closer communications pathways from the CIC to the bridge. This allowed them to basically see the CIC's displays and make faster, more efficient and better decisions.

"We identified the key stakeholders, determined a shared vision and brought the CIC to the bridge," added Reis "This allowed us to execute the most demanding aircraft carrier schedule in recent times during two deployments and 640 days at sea."

More recently, Reis used this know-how to leverage tactical advantages in the process industries. For instance, GE formed an alliance with Chevron in February 2014 to improve oil and gas extraction from the 11,000 wells in the historical Kern River oil field near Bakersfield, California.

"These wells have been producing oil, gas and water for many years, and now this partnership is using microwave and Doppler radar to determine the temperature, pressure and other conditions in the reservoirs," explained Reis. "We're using the Safire and multiphase technologies that Chevron and GE developed together, and this helps us make better decisions about the most appropriate method for drawing out and cleaning the oil. Previously, samples were collected every 30 days, but now we can find out about reservoir conditions immediately, and this means much better optimized production." ■

FROM ASSET AND SYSTEM MONITORING TO ENTERPRISE OPTIMIZATION

Research Centers, Development Platforms, Software Suites and Monitoring Centers Cover All Points of the Industrial Internet

by Mike Bacidore

The GE Software Center of Excellence (CoE) in San Ramon, California, employs more than 1,000 people developing enabling technologies for the Industrial Internet. "Four years ago, GE made a major investment, doubling down, because it saw big opportunities," said John Magee, CoE chief marketing officer, who spoke to a packed room at the GE Intelligent Platforms 2014 User Summit in Orlando, Florida. "There's been a particularly good collaboration with GE Intelligent Platforms."

The CoE is the hub of GE's Industrial Internet thinking. "This is where the Predix platform was developed," said Magee. GE has big designs on taking optimization from the individual-asset level up to the process level and then extending across multiple assets and processes to the business level. "There's a bigger opportunity to link that with the enterprise and the whole business," explained Magee. "The data that's collected can start to be leveraged in a lot of new ways."

The big benefits of asset performance management (APM) include equipment reliability, cost reduction, risk mitigation and profitable growth. GE's APM capabilities for industrial companies include monitoring and diagnostics (M&D), asset lifecycle management, predictive maintenance and operations intelligence.

"What does it take to focus on APM?" asked Magee. "We've got to have connectivity and data. M&D has been around for years, but the potential goes much deeper. Real-time visibility makes for better decisions about asset lifecycle management. And operations intelligence is getting the right information to the right people when they need it."

Leveraging the technology requires connecting to a lot of different devices, so systems, and not just assets, can be optimized. GE's also focusing on mobility and cloud-based collection and analytics, but not by neglecting local data needs. "Industrial customers are subject to a lot of regulatory requirements," explained Magee. "It's not all about putting everything in the cloud. We need to be able to run analytics where they need to run. There are reasons to keep some

"The data that's collected can start to be leveraged in a lot of new ways." GE's John Magee on the company's major investments in software analytics capabilities.

processing local and some in the cloud."

The Predix software platform is a way for GE to develop Industrial Internet solutions that close the gap between operations technology (OT), such as PLCs, gateways and SCADA, and business systems (IT), which include ERP, CRM and supply chain systems.

GE's Proficy Monitoring & Analysis Suite (PMAS) is an integrated stack of industrial data-management and analytics software coupled with industry-specific solutions and cloud services. It comprises solutions that match neatly with the points on GE's Industrial Internet Maturity Model—connect, monitor, analyze, predict and optimize.

Proficy Historian and Historian HD provide the abilities to connect and monitor. "Historian can be deployed in a machine control and HMI SCADA all the way up to the cloud," explained David Bell, commercial leader, GE Intelligent Platforms. "It scales in all of those levels. We're employing some visualization technology from the Predix platform, and it's based on HTML5 Web technologies, so it allows you to have the Web browser automatically adjust to your display."

Analysis capabilities come from Proficy Historian Analysis, the companion product to Historian, which has been fully migrated to the Predix visualization platform in HTML5 that allows browser-based access to data for ad hoc analysis, and from Proficy Knowledge Center, which expands on the capabilities in Historian Analysis to be more of a fleet management solution. For a view of many assets distributed across an organization, Proficy Knowledge Center has geographic views and dashboards. Further, it integrates with the Industrial Performance and Reliability Center (IPRC), a GE monitoring center in Lisle, Illinois, where analysts using Proficy SmartSignal can keep predictive tabs on equipment on one's behalf. Proficy SmartSignal detects the very early signs of deterioration and failure, allowing more proactive maintenance strategies.

The final step, optimization, is enabled by Proficy CSense. From managing data and analyzing it to visualization and workflow, users can take the analyzed data and do something with it. PMAS supports APM through M&D, predictive maintenance and, most importantly, operations intelligence. "How do you improve your operations?" asked Bell. "This is beyond just diagnostics. The idea is providing a stack of software that allows people to access data and support when they're not at the control panel. Regardless of where you are, you can help to support the operation of the equipment."

SmartSignal is just one piece of the PMAS being used by the IPRC. "We help customers to find the earliest indications of failure," said Chad Stoecker, who manages the IPRC. "Our experienced equipment and software engineers monitor more than 5,500 assets with more than 200,000 sensors seven days a week for more than 85 sites globally in mining, oil and gas, power generation and aviation. Each week, we average 1,100 advisories, 100 cases, in which we notify customers of a problem, and 40 catches, where customers confirm back to us that they wrote a work order or did maintenance to correct a problem."

The biggest hurdle to success for the IPRC and PMAS is the acceptance of automated diagnostics and analysis. "We're really in the business of helping customers make cultural transitions in their companies," explained Stoecker. "We have to collaborate with customers and help them drive a proactive maintenance culture. Collaboration and trust is needed to drive truly remarkable results."

Stoecker described one example, which involved a combustion turbine at an oil and gas facility. At first, a small increase in vibration was noted, but the customer needed to be convinced that the increased vibrations indicated damaged blades on the turbine. Stoecker's group continued to monitor the turbine. The vibration went away temporarily and then reappeared. "We brought in a vibration expert to convince them," he said. "The blade was three to five days from failure. The replacement was done during a scheduled outage, saving the company $30 million of potential lost production and repair costs." ■

VISIBLE DATA MEANS OPERATIONS EXCELLENCE

Coca-Cola and GE Lighting Use Proficy Workflow, Historian, iFix HMI SCADA and Portal Software to Streamline Lighting and Refreshment Production

by Jim Montague

Seeing is believing, and bringing operational information into the light makes it usable by everyone in an enterprise—allowing them all to make faster, more productive decisions.

This enhanced awareness was especially useful at GE Lighting, which recently reinvented itself to transition from manufacturing millions of homogenous, incandescent light bulbs to developing tailored, LED lighting solutions for its many customers.

Similarly, Coca-Cola gained new insights to help further optimize production, while also taking advantage of cloud-based data gathering, analysis and protection. These experiences were described by Craig Platt, IT director at GE Lighting, and Ioan Batran, automation engineering director at Coca-Cola Refreshments (CCR), in their presentation, "Operational Excellence: Improve Data Visibility Across the Enterprise" at the GE Intelligent Platforms 2014 User Summit in Orlando, Florida.

"Incandescent bulbs were our bread and butter, but now it's going to be unlawful to manufacture them. Fortunately, we're prepared on the LED side, but we also had to combine a 75-year-old business with what is basically a start-up organization," said Platt. "Where lighting used to be a replacement business at the back of the supply chain, we had to move further up into the supply chain because LED is a fixtures-and-solutions business. So instead of making 3.5 million of the same bulb per day at one plant, we had to move to configuring LED solution for individual users. We also had to reduce our order-to-ship (OTS) cycle time from 30 days to 10 days and improve our OTS fill rate from 70% to 90%."

With help from its reorganization and GE's Proficy Workflow software, Platt reported that GE Lighting streamlined its assembly and OTS processes, reconfigured and integrated its manufacturing lines, improved its raw material flows and implemented a visual material management system. "We created a supermarket and mini-market approach, used Kanban cards and flow, adopted on-demand label printing and got down to 10 days for one product line

"We can compare the performance of plants, lines and even individual machines." Coca-Cola Refreshments' Ioan Batran on the company's 70-plant deployment of KPI dashboards based on GE Intelligent Platforms technology.

and then added others," said Platt. "In fact, our mini-market picking is done with wearable, on-wrist PCs that are all controlled by our overall MES system. Now customers can see their units as they're manufactured, and this gives everyone more confidence."

Refreshing Soda Pop Production

Meanwhile, though it's been using Proficy software for many years, Batran reported that Coca-Cola recently revamped its application at 70 manufacturing facilities. "We focused on reducing complexity in our supply chain, pushed back against inefficient customization, did a lot of root cause analysis and concentrated on useful action," said Batran. "In our line information systems (LIS), we sought to better track line assets, increase efficiency, reduce equipment losses and downtime, and improve our decisions. Our LIS basically tells us if we're meeting our promises."

Batran added that all levels at Coca-Cola's production facilities need data from their LIS, so simplifying their software and standardizing their control architectures makes them easier to deploy and support. This 70-plant renovation began by updating the LIS server at each facility with Proficy Historian, iFix HMI SCADA and Portal dashboard software. These solutions allow each LIS to deliver real-time and historical data, and then push reported KPIs to an SQL enterprise database via Sync Agent software and Microsoft Azure to Coca-Cola's cloud-based server.

"We started this program last year, and now we can compare the performance of plants, lines and even individual machines," explained Batran. "LIS management routines and practices measure and manage our manufacturing processes to maintain and improve performance," said Batran. "We're also implementing paperless guidance, so we can further un-cloud our crystal ball and focus our decisions more precisely on what we need to do."

These improvements allow the LIS to generate tactical reviews that let users respond to specific operational events, and produce strategic reviews that let them address continuous improvement efforts by identifying trends, patterns and root causes. "The reviews help us implement better management routines, which need to be backed up by appropriate levels of change management," added Batran. "You also have to secure leadership support and stakeholder buy-in."

Views available on Coca-Cola's LIS-based system include plant overviews, production line layouts, historical machine status, short-interval control reports, enterprise-level displays and others. These displays can be presented on PCs, tablet PCs and smartphones. "The enterprise LIS even lets us see selected KPIs on multiple lines, so we can compare the performance of different machines," added Batean. "Next steps include implementing more paperless capabilities and autopilot management routines, as well as improving overall management routines, coaching and auditing." ■