When Critical Systems Sense Their Future

Proactive Lifecycle Management, Born of Disaster, Poised to Change Lives

From Paris to San Francisco, from Christchurch to Murmansk, much of our daily activity, health, safety, and commerce rely heavily on information technology (IT) as an enabler. The following is our vision of the future of IT and how it will grow to serve us all more effectively.

This is a forecast of major shifts in the efficiency and economics of IT support, supply chain management, systems capacity and readiness, network traffic control, and the design and lifecycle of uber-relevant IT tools and services. These shifts are due to new capabilities for sensing the health and compliance of systems and exploiting the rich data they produce.

While these capabilities stem from early disaster avoidance efforts in air travel, they're becoming more and more prevalent lifecycle enhancements in IT. The good news is that the seeds of what we describe here are already starting to sprout.

Twin blades chopped grey November sky as the Chinook skimmed toward the crisscrossed runways and rocky ledges dividing the Atlantic Ocean and the North Sea. There on the southern tip of the main Shetland Island, a Sumburgh flight-controller waited for the helicopter shuttle to return from oilfields nearby.

The shuttle never made it. Instead, a single gear in a rotor transmission failed, dooming the aircraft to a sudden crash that killed all but two of the 47 passengers and crew. This 1986 tragedy is often cited as one of the triggers in developing early monitoring systems that can use data collection and analysis to help ensure the availability, reliability, and safety of commercial passenger vehicles.

NASA started practicing proactive lifecycle management long before *Apollo 13* astronaut Jim Lovell said the famous words, "Houston, we've had a problem." Today, General Electric calls this practice the Industrial Internet, Rolls-Royce, deems it "Equipment Health Management" (EHM), and for Boeing, "Airplane Health Management" (AHM).

The industries, brands, and capabilities may differ, but the theme is the same: proactive lifecycle management, born of disaster, poised to change lives.

When IT is Critical

As IT Director for a healthcare provider with accredited hospitals, clinics, and medical centers all over China, Zoey[1] hasn't always slept well. She has a lot on her mind.

Tens of thousands of patients, nurses, doctors, and staffers rely on the applications and services supported by her IT department and their data centers. For patients, this reliance can be a matter of life and death. That's why on the morning she walked into her office to hear, "We had a potential crisis last night but solved it before it became critical." She breathed a long sigh of relief. The preventative monitoring had worked.

A server sensor had automatically reported a high temperature reading back to the support provider's trouble ticket automation system, which in turn had warned her staff. And it was a good thing, too: there was a problem in the cooling for the entire data center. Without the warning, several servers, storage, and networking units could have failed in the heat, crippling medical services for thousands.

It's a scenario that's repeating itself around the world. Preventative monitoring can save time, protect company assets, reduce costs, increase efficiency — and, most important — save lives. But there's a lot more to this story.

Ready, Aim, Troubleshoot

In describing their proactive and preventative EHM philosophy, Rolls-Royce highlights the ability to isolate system issues using data and analytics instead of having to "open the equipment."

In enterprise IT ecosystems, we can now proactively monitor hundreds of faults in devices which include but are not limited to: backup systems, CPUs, memory, virtual disks, physical disks, bus devices, controllers, surge protectors, cables, power supplies, voltage regulators, batteries, network devices, chassis, system boards, enclosures, fans, and many of other components.

But component *health* is not the only issue. In many IT situations, sub-optimal performance can be nearly as costly as failure. That's why proactive monitoring also enables performance tuning and optimization.

It's the same for all critical systems. At its most basic level, the promise inherent in persistent automated monitoring and analysis is that it can save maintenance time, increase system availability, and improve performance — and therefore reduce costs and increase productivity.

Consoles: Not Just for Star Trek

Have you ever noticed how many consoles there are on *Star Trek's U.S.S. Enterprise*? There are dozens of consoles on every deck. And what do those consoles do?

They provide real-time status updates, communications, and control for the ship's critical systems. The engineers monitor and tune the propulsion and guidance systems. The science officer monitors communications. The medical staff monitors the health of crew members.

One of the largest public school districts in North America does the same thing. No, they aren't teleporting children to other planets, but they are boldly educating thousands of students every day.

They watch console-driven status maps on large monitors in their main data centers. Warnings display as text messages on technical staff smart phones.

But consoles aren't just for large interstellar or educational operations. Much of the proactive monitoring and data production we describe in this article relies on basic, turn-it-on-and-leave-it-alone consoles on the user end.

The rest of the data mashup and analytics is up to the warp-drive processes that critical-system vendors are establishing right here on Earth.

1 To protect the privacy of the individuals in this story, we have changed the names.

Taking the Voodoo out of the Supply Chain

Most of us take for granted the crates and boxes of spare parts that follow mission-critical machines and computers around the planet. But how do companies determine how many and which parts really need to be shipped, and to which locations?

Traditionally, parts inventory levels are maintained through a set of guidelines such as MAX/MIN or PAR. In a typical break-fix approach, a series of interrelated components (several parts in a "hero" kit) might be replaced as a matter of course when, in reality, only one part actually caused the problem. These practices are not always efficient.

What if we could more accurately estimate the demand for parts, based on persistent analyses of data coming directly from the machines? We could manufacture, ship, and store fewer parts, pass the cost savings on to the end buyers, and reduce the impact of transportation and storage on the environment. Even better, with preventative monitoring we could have an automated "pre-order-on-demand" system: the ultimate in spare-parts efficiency, and a big step toward near self-healing systems.

Optimizing the Motto "Always Prepared"

The oil embargoes in the 1970s were wake up calls for much of the planet: we learned to turn things off. Our sensitivity to efficiency and conservation has grown steadily ever since, but so has the complexity of our businesses. How do we optimize our usage down to the processor level, how do we maintain elasticity, in a timely way, whether in traditional, virtual, or private, public, or hybrid cloud environments?

For example, cloud environments must be able to handle fluctuations in user traffic and volume. Load balancing helps, but servers can still be overwhelmed by unpredicted overloads. Before placing workloads on a cloud server, administrators should know which workloads and service levels they will need to deliver, but that's not always easy.

Is there a more sensitive way to handle potential issues in real time? The answer is persistent automated monitoring, data mashup, and near real-time analytics, especially in cloud-based or virtual ecosystems.

It's the same for network traffic. Network traffic optimization means different things to different people, but often it involves audits, assessments, surveys, and tests. As with all of IT, rapidly changing technology and business landscapes such as bring-your-own-device (BYOD), cloud, software-defined networking (SDN), and software-defined storage (SDS) are always in play. At the heart of the networks are the components — routers, switches, and wireless access points — that could provide a constant stream of data to help predict failures and overloads in near real time, which could help maintain elasticity.

We Didn't Design It, the Workload Did

As Scott Dadich describes it in *Wired,*[2] "we're entering a new era, one in which designers create experiences centering not on physical objects but on the fabric of digital information that surrounds us. That's the next great challenge for design: weaving the threads of technology, information, and access seamlessly and elegantly into our everyday lives."

Imagine a server or storage device design based entirely on the workload, volume, ambient temperature, and power demands in a single industry — a design based on the analysis of tens of thousands of hours of data automatically fed through remote monitoring. Think of the value that could be mined from billions of mashed-up data points regarding system loads and health from all around the planet. The design of new systems would be almost invisible and would become the ultimate in outside-in.

> What if we could more accurately estimate the demand for parts, based on persistent analyses of data coming directly from the machines?

2 http://www.wired.com/2013/08/the-age-of-invisible-design/

Proactive Lifecycle Management Enables...

Monitoring system health at a component level	Operating system and application productivity	Spare-parts efficiencies	Near real-time workload and demand optimization	Network traffic optimization	Invisible product design
↓	↓	↓	↓	↓	↓
Maximized system availability through preventative maintenance	Consoles as integral part of lifecycle management	Cost savings and reduced environmental impact	Higher sensitivity to loads and quicker to balance	Improved bandwidth and resiliency, and decreased latency	Products that more closely align with specific needs and use cases

Why Now?

How is all of this possible? What technologies are driving these new capabilities? Gathering data from sensors is only part of the story. The more difficult challenges are analyzing and understanding all the available data and then effectively disseminating the lessons learned. We're now in a perfect storm of technological advances that enable proactive lifecycle management:

- **Sensors** — They are a growing part of our lives. According to a recent research report from the Freedonia Group, U.S. sales of sensors are forecast to climb at a 6.1% annual rate through 2016 to $14.9 billion.[3]

  Design News Senior Editor Rob Spiegel blogs: "Sensors are becoming smarter, more connected, and less expensive. They are showing up in a wider range of settings, from vision sensors on the plant floor that allow robots to work next to people without hurting anyone to medical sensors that continuously monitor a patient's vitals."[4]

  GE Software reports that sensors enable one gas turbine compressor blade to have the monitoring potential of 500 gigabytes per day.[5] That's equivalent to around 100 DVDs of data from one machine. Sensors are in plentiful supply in critical IT systems as well. For example, Dell can currently monitor thousands of types of events in their enterprise systems.

- **Data and Analytics** — Collecting data isn't the biggest hurdle. Carolyn Mathas, writing in *Electronic Products*, sums up this universal challenge in the context of military usage: "...with real-time systems now employing data streaming, massive storage, and advanced pattern recognition, the military and its vertical market offshoots are lite rally drowning in data. It is the analysis – making sense of all of the data – that sometimes lags the collection capability."[6]

  So how do we handle these large volumes and disparate types of data? Enter Hadoop.[7] Apache Hadoop is a platform for storing, structuring, processing, and analyzing large volumes of disparate data. It's designed to be scalable and cost effective, with flexibility regarding types of data and built-in fault tolerance. Hadoop is "the little engine that can" in a world of big data. Without it, we would not have the analytics capability to handle the volume and disparity from all the sensors out there.

- **Internet of Things (IoT)** — There are three primary drivers that contribute to the IoT and its expanding part in managing large volumes of data: social, cloud, and mobile.

  David Talbot *of MIT Technology Review* observes, "With the advent of the IoT, potentially billions of devices will report data about themselves, making it possible to create new applications in areas as diverse as factory optimization, car maintenance or simply keeping track of your stuff online." Talbot goes on to talk about "dweeting," or the ability to publish streams of data to a web page from any device connected to the Internet.

  Using social networks to disseminate temperature, speed and other critical data points could serve to democratize the availability of this type information, making it possible to quickly and easily share raw data, trends, recommendations, and warnings to worldwide audiences, whether enterprise or consumer.

3 Sensors to 2016 - Industry Market Research, Market Share, Market Size, Sales, Demand Forecast, Market Leaders, Company Profiles, Industry Trends, Freedonia Group Inc., 10/2012
4 Sensors Are Everywhere: From the Factory Floor to Your Skin, Rob Spiegel, Senior Editor, Automation & Motion Control, Design News, 7/28/2014
5 GE Software, How the Industrial Internet Will Transform Services, 5/7/2014
6 http://www.digikey.com/en/articles/techzone/2013/jun/military-applications-are-driving-advances-in-sensor-technology
7 Apache Hadoop is a registered trademark of the Apache Software Foundation.

- **Cloud** — Private, public, and hybrid cloud technologies enable the use of expansive resources, especially for data storage and analytics. Coupled with powerful processors and best-practice linking applications, cloud technology provides the secure, high-performance computing capability that preventative monitoring requires, at a fraction of the cost.

- **Mobile Devices** — The proliferation of mobile devices enables proactive and predictive monitoring and management from practically anywhere around the world. That's a lot of access points for warnings, information, decision making, maintenance approvals or alerts, and follow-up. And mobile devices themselves are starting to come with sensors that can relay data about their own status.

Privacy and Security, the Paramount Twins

It's a fact of modern life: data is an enabler. But that doesn't stop us from worrying about data privacy and security, and it never should. We must remain diligent, especially regarding personal information. But what about safeguards for the more benign data on performance and health of critical systems?

Protection of system data should rely on the same systems and practices recommended for personal information and should use a wide variety of privacy and security measures. These include physical, network, server, database, and procedural security, regular auditing, and annual employee training. Only technical support and analytics teams should have access to the data, which should never be shared for promotional purposes.

What Happens When Critical Systems Sense Their Future

The critical systems that enable business, health, safety, crisis recovery, education, science, and more are a growing part of our lives. It's vital that we continue to design ways to keep them productive. One of the keys is designing proactive lifecycle management systems that can sense their future. And for IT environments – the brains of the critical systems family – this principle is absolute.

Businesses and organizations have an evolving opportunity to partner more closely with their hardware and software providers to keep their systems, applications and workloads in constant operation. But this is also a cultural change. For many, it means leaving decades of a break-fix mentality behind and embracing a new approach to maximizing system availability. By taking the "break" out of break-fix, with vigilant sensors and analytical prediction, IT professionals enable scheduled efficient maintenance instead of downtime. Emergencies can be averted.

The 1986 Shetlands helicopter accident highlighted concerns about safety standards on North Sea flights. That year the United Kingdom's Department of Transport announced it would spend £500,000 on helicopter safety research. The aircraft industry matched the sum and the Civil Aviation Authority contributed funds as well. The 45 souls lost in the tragedy weren't forgotten, but instead prompted an evolution in monitoring, maintenance, safety, and productivity.

Proactive lifecycle management was born of disaster, and it remains poised to change lives.

By taking the "break" out of break-fix, with vigilant sensors and analytical prediction, IT professionals enable scheduled efficient maintenance instead of downtime.

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