

Using Analytics to Improve Healthcare Outcomes

Turn massive, isolated data sets into actionable insights at the point of action

Big data analytics will transform every industry, and none more than healthcare. To simplify integration, Intel is working with GE to deliver Predix® for Healthcare, a computing platform designed specifically for integrating applications and for sharing and analyzing large, complex data sets. Predix will help healthcare providers turn mountains of isolated data into actionable insights across the full continuum of care.

"The road to sustainability for most healthcare organizations includes improving visibility, control, and automation. Success depends, first and foremost, on breaking down traditional data silos."

– **Mike Mast,**
Global Director of Marketing for
Health Systems Solutions at GE
Healthcare IT

Executive Summary

Healthcare costs are rising at an unsustainable rate, but how do you cut costs without limiting patient access or treatment options? Emerging big data technologies provide an answer. Companies across many industries are analyzing massive amounts of data to deliver actionable insights in fractions of a second, so they can make better, faster decisions. These technologies have the potential to transform healthcare by enabling more accurate diagnoses, improving operational efficiency, and identifying evidence-based treatment plans that deliver better results with reduced risk.

Of course, integrating big data analytics into complex healthcare environments is no easy task. Data is abundant, yet much of it is distributed and isolated. There is no efficient, cost-effective way to generate a holistic view of a single patient, much less to bring all data together for real-time analysis.

This paper defines a strategy for eliminating those barriers in an incremental way that delivers increasing value over time. There are two key components.

• **A Computing Platform for Analytics-Driven Healthcare.**

Built by GE with support from Intel, Predix® for Healthcare will make it easier to deploy, manage, and integrate new and existing applications and devices, to unify and analyze all available data, and to deliver insights to the right people at the right time to improve outcomes.

• **Applications that are built for Data Sharing.**

Healthcare applications are changing. Modern solutions not only help to improve quality and efficiency for discrete operational areas such as operating theaters or population management; they also help to break down the barriers that limit data sharing among all data sources, both new and old. With each new application, data becomes less isolated and more accessible.

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Running modern applications on a platform that is specifically designed for data sharing and workflow integration doesn't eliminate the challenges of implementing advanced analytics, but it does make the job easier. Instead of focusing on hardware and software issues, development teams can focus on data, information, and workflows—the issues that have a direct impact on the quality and efficiency of care.

We are entering a new era in which the ability to collect and analyze large, diverse, and fast-moving data sets is driving new efficiencies and better outcomes across some of the world's most complex processes. We believe these capabilities will ultimately transform every industry, and that they offer particularly high value to healthcare organizations as they strive to deliver better care at lower cost.

Healthcare at a Crossroads

Modern medical science has dramatically increased our ability to promote health and to understand, diagnose, and treat diseases. Yet, with the increasing flood of advances have come enormous increases in the cost and complexity of healthcare delivery. Costs are rising faster than population growth and faster than inflation¹, putting financial pressure on everyone involved, from patients and healthcare providers to insurers, governments, and whole economies.

Political and demographic changes are adding to these challenges. New legislation, such as the Affordable Care Act in the United State, which enacts a major overhaul of the healthcare regulatory environment, is driving more individuals to seek healthcare. People are also living longer, so providers are encountering a higher volume of age-related conditions that require multiple touch-points, long-term treatments, and extended hospital stays. Healthcare organizations must find a way to meet these growing demands, yet they must do so while containing, and ideally reducing, the cost of care.

The bigger challenge that lies behind all of these issues is the extraordinary complexity of healthcare delivery. The inherent complexity of the human body and all that can go wrong and right with it is multiplied by the difficulty of diagnosis, the plethora of treatment options, and the complex interactions that take place among multiple, disconnected providers and payers. And there is no fixed target for today's healthcare organizations. Medical understanding, diagnostic tools, and treatment options are evolving faster than ever, so knowledge, resources, and processes must be continually updated.

This vast complexity has led to substantial inefficiencies throughout our healthcare delivery networks. It is generally accepted today that waste accounts for somewhere between 20 and 40 percent of the USD 3 trillion U.S. healthcare industry and similar levels of waste exist around the world. Some of the major sources of this waste include:

- **Inefficient asset utilization.** A typical hospital in the U.S. runs at between 60 and 70 percent of its capacity.²
- **Variance in clinical decision making.** Patients with similar symptoms are treated differently in different hospitals, even by different doctors within a single facility. Rarely are these differences based on clinical evidence.
- **Fragmented care.** Patients follow a complex care pathway among multiple providers who often have little or no visibility into each other's test results, diagnoses, and treatment plans. Duplicate services are common and care is reactive rather than preventative.

Mounting Pressure for Change

As providers work to solve these quality and efficiency issues within their own facilities, they are also dealing with change and uncertainty in the broader healthcare industry. With online access to information, patients have become more informed and demanding. They have higher expectations and are in a better position to evaluate and compare treatments and providers.

Even more importantly, financial models are changing. With new value-based reimbursement (VBR) models, revenue is no longer based on the volume of services provided. Instead it depends, at least in part, on the effectiveness and efficiency of the services delivered.

In some cases, full reimbursement requires demonstrating that care delivery meets certain quality and efficiency benchmarks; in others, payment amounts are fixed for a particular event, such as a knee replacement. In these and other VBR scenarios, providers are facing new requirements and taking on more risk. Organizations that have worked hard to keep beds, operating rooms, acute care units, and imaging facilities operating at maximum volume are increasingly looking for ways to keep patients healthy while minimizing the need for such high-cost services.

Lots of Data, Not Enough Insight

Improve quality and maintain profitability, providers need deeper visibility into the cost and quality of the care they deliver, so they can make targeted changes that deliver real value. The data exists to provide this visibility. The healthcare industry is awash in data, from electronic medical records (EMRs) and picture archiving and communications systems (PACS) to the databases that support workflow solutions, specialty applications, and billing systems.

Unfortunately, healthcare data is distributed and isolated across multiple organizations, facilities, departments, applications, and databases. Data formats vary widely among applications, imaging systems,

and EMRs, and many data sources are not yet interconnected, even across departments in a single hospital.

In this world of isolated data, there is no efficient, cost-effective way to generate a holistic view of a single patient; much less is there a way to evaluate clinical decisions in light of financial and operational data. Bringing all this information together and using it effectively is one of the biggest challenges faced by the healthcare industry. It is also one of the biggest opportunities.

Ultimately, providers will need to have visibility across all their patients, caregivers, and facilities. They will also need to share data efficiently with external organizations, so they can avoid duplicating efforts.

New Technologies Open New Doors

Technology solutions are available today that can help healthcare organizations transform their isolated data sets into one of their most valuable resources. You experience the power of these solutions when you use the Google search engine or shop at Amazon. These and many other Internet companies are combining and analyzing multiple petabytes of data to deliver finely tuned information and offers to their online visitors within fractions of a second. To put that in perspective, one petabyte of data would be enough to record the DNA profiles of every person in the U.S. in triplicate.

Other industries have taken note of this online revolution. Data volumes are exploding in every sector, with much of this growth being driven by the emergence of the Internet as a preferred location for transacting business. Now many companies are connecting machines and sensors via the Internet. This new model, sometimes referred to as the “Internet of Things,” is driving unprecedented increases in the speed, variety, and volume of data generation (see the sidebar, Brace Yourself for the Internet of Things). It is also introducing new opportunities for monitoring and controlling complex, distributed processes.

Many businesses in data-intensive industries, such as financial services, telecommunications, retail, and manufacturing have already deployed big data solutions to mine strategic and tactical value from their fast-growing data sets. Importantly, these solutions don't require large, costly computing platforms. Instead, they provide massive scalability and high reliability by running on clusters of affordable, mainstream servers.

The past few years have seen dramatic leaps in server performance to support the immense processing demands of big data analytics. A standard server based on Intel® Xeon® processors provides roughly nine times the performance of a comparable server from just four years ago³, and new Intel storage technologies are eliminating traditional data access bottlenecks.⁴ Given the dramatic performance improvements delivered by these computing systems, the cost models for big data implementations are now well within the reach of most organizations.

Healthcare has much to gain. Big data analytics provide the ability to combine and analyze all available data—clinical, financial, and operational, as well as external data sources, such as medical research, diagnostic references, and pharmaceutical libraries. Clinicians can potentially be presented with filtered information based on each patient's complete and up-to-the-moment medical history, lab work, and symptoms, all integrated with best practices recommendations based on research and comparable cases culled from large populations.

With this information, providers will deliver care that is more evidence-driven and personalized. They will have deeper insight into what is most likely to work for individual patients, and a better understanding of costs and risks. Financial and operational teams will have comparable, real-time insights into the strategic and tactical issues that help them deliver better care at lower cost.

Deeper Insight at Every Decision Point

Today's leading big data solutions can provide real-time insights at the scale needed to support a large healthcare provider. However, realizing the full potential of big data analytics requires, first, that data can be accessed and aggregated for analysis, and second, that the resulting insights can be delivered to the right people at the right time to improve decision making.

GE is working with Intel to simplify this complex process by providing a computing platform designed specifically for hosting integrated applications and for sharing and analyzing large, complex data sets. Known as Predix®, this scalable, high-performance platform can be used across all industries, including healthcare, to automate operations and improve information flow. It provides an industry-leading stack of technologies for distributed computing, big data analytics, asset management, and machine-to-machine communications. Predix also provides a foundation on which to build, deploy, and integrate intelligent software applications, with strong, built-in support for security, collaboration, and serviceability.

Predix is optimized for mobile computing, which will be increasingly important to support efficient information flows in integrated, analytics-driven healthcare environments. Mobility allows data and insights to be generated and consumed almost anywhere, and to have an immediate impact on facility-wide decision making. Ongoing advances in mobile solutions are making it easier for clinicians to access all their applications and information—including high-definition medical images—as they move about and engage with their patients and colleagues.

(For information on recent technology advances and emerging usage models, see the Intel web site for Mobile Healthcare at: <http://www.intel.com/content/www/us/en/healthcare-it/mhealth-powering-the-health-workforce.html>)

A platform such as Predix cannot solve the complexities of process optimization, because those challenges are specific to every business and every industry. However, it does provide a pre-integrated foundation that makes it easier to address those issues. GE Healthcare is extending this core big data framework to provide targeted support for healthcare requirements (Figure 1).

Capabilities for healthcare include:

- **Support for HIPPA compliance**, and also for medical device integration and healthcare IT standards, such as HL7, CDA/CCDA, DICOM, XML and more. This support simplifies integration into healthcare environments, with reduced risk and better interoperability with both new and existing devices, applications, and data sources.
- **Clinical decision support** with a framework for aggregating data from devices and software to deliver actionable, patient-specific insights within the context of clinical workflows.
- **A clinical workflows and rules engine** for optimizing workflows based on specific needs, roles, and other requirements.

Predix for Healthcare provides an optimized, big-data enabled foundation for all GE healthcare applications. By providing a unified platform, it will enable faster innovation with reduced cost and risk. As the complexity of healthcare continues to increase, integrated care applications backed by big data analytics will provide a foundation for continuous improvements in quality, efficiency, and outcomes.

Information When, Where, and How You Need It

Maximizing the value of a big data platform, such as Predix for Healthcare, requires breaking down barriers to data sharing. The new generation of healthcare applications can help, while also

making it easier to preserve the value of existing applications.

Over the past few decades, healthcare applications have typically focused on providing targeted solutions within specified areas. Clinical, financial, and operational applications have remained isolated, with little if any sharing of data. That is changing with the new wave of applications that are specifically designed to support a more integrated approach healthcare delivery.

As before, applications target specific functions, such as Emergency Room (ER) management or billing. However, modern applications are designed for flexible data sharing and workflow integration (Figure 2). They have standard application programming interfaces (APIs) and offer broad support for healthcare IT standards, such as HL7, IHE, and DICOM. They also include configurable tools that make it easier to address unique workflows and changing requirements.

Because they are designed for data sharing and interoperability, these applications not only deliver needed functionality, but also increase an organization's ability to combine and analyze data. With each new application, data becomes less isolated and more usable—an ideal complement to a computing platform, such as Predix, that is designed specifically to enable smarter, more integrated, and more unified care.

These newer applications also make it easier to take advantage of the insights generated by data analyzes. Data and information can be integrated back into existing workflows and delivered to the right person at the right time to improve decision making.

The following are examples (based on GE Healthcare applications) of the kinds of software tools that are available to address critical near-term needs, while simultaneously improving your ability to share, use, and analyze previously isolated data sets. None of these applications require Predix, but all will deliver higher value when integrated with the Predix for Healthcare platform.

Enterprise Imaging

The first step in delivering efficient, high quality care is making faster and more accurate diagnoses. An enterprise imaging solution provides advanced tools to improve imaging workflows, visualization, archiving, and collaboration. New cloud-based solutions offer a particularly efficient way to share images quickly and securely among radiologists and other clinicians across geographical and organizational boundaries. Remote clinicians don't need specialized tools or applications. They can connect securely using a standard Internet browser. This opens the door to efficient consultation with specialists, no matter where they practice or what tools they use.

• Enterprise Imaging in Action.

By upgrading their imaging systems, a medical center in the U.S. realized an 89 percent reduction in turn-around-time for point of care tests⁵, while a hospital system in Poland has saved up to 19 percent of its radiologist's time.⁶

Care Delivery Management

Care delivery management applications offer fundamental advantages for improving the quality of care while enhancing productivity. Providers can streamline primary and specialty care workflows, including clinical documentation, quality reporting, analytics, and surveillance. Depending on their needs, a healthcare organization can target overall efficiency with ambulatory EMR solutions or they can target their most high-cost, high-risk specialty areas, such as acute care, cardiology, or maternal infant care.

• Care Delivery Management in Action.

A bone and joint clinic in the U.S. was able to increase the time clinicians spend with patients, and increase overall patient volume by 18 percent.⁷ A medical center in the U.S. improved its surgery turnover time by more than 20 percent.⁸

Population Health Management

Efficient care increasingly requires keeping patients out of the hospital, and even out of the doctor's office, through effective preventive and proactive care. Population health solutions provide better tools for understanding and managing patient health across complex networks. They provide a single view of the patient with predictive analytics and alerts to identify at risk individuals and groups. They also provide health empowerment tools for patients and administrative dashboards that match patients and populations with the providers that can best meet their needs.

• Population Health Management in

Action. A care plan in the U.S. is implementing a population health management platform to deliver accountable care to almost 400,000 patients. Decision support tools with automated alerts are helping them close care gaps to improve outcomes and reduce risk. (For details, see the Caradigm case study at <http://www.youtube.com/watch?v=0o2uDRDiksQ>)

Financial Management

As healthcare providers implement new value-based reimbursement (VBR) models and take on more risk, they need tools that help them stay profitable while still delivering solid patient outcomes. Healthcare financial management applications simplify the complexity of today's revenue lifecycles across people, departments, and facilities, and across multiple public and private payers. Financial and clinical data are combined with built-in intelligence and automation to identify bottlenecks and inefficiencies, minimize manual intervention, and improve outcomes. This integration can help to increase and accelerate revenue streams and reduce administrative overhead.

Brace Yourself for the Internet of Things (IoT)

Today's Internet connects mostly people, but a shift is underway. Businesses are connecting sensors and machines, so they can monitor and control complex and distributed processes, such as managing an airline, an electrical grid, or a global telecommunications network.

Healthcare is no exception. Most data is still entered by hand, but smart, Internet-connected devices are growing in number; and new technologies, such as wearable patient monitors, lab-on-a-chip diagnostic tools, and desktop DNA profilers, will ultimately generate torrents of new data.

With the right foundation for collecting, analyzing, and using these massive new data flows, the resulting insights will fuel a major transition toward medicine that is more accurate, efficient, personalized, and preventive.

For more information about the transformative power of the IoT and big data analytics, see:

- Personalized Medicine and Analytics, an Intel website: <http://www.intel.com/content/www/us/en/healthcare-it/big-data-in-healthcare.html>
- "The Industrial Internet, Pushing the Bounds of Minds and Machines," a GE whitepaper: <http://files.gereports.com/wp-content/uploads/2012/11/ge-industrial-internet-vision-paper.pdf>

• Financial Management in Action.
A medical group with more than 200 physicians was able to reduce administrative staff by 20 to 30 full-time employees, while reducing total billing costs to just 2.4 percent of gross revenue and achieving a 99 percent collection rate on eligible billing.

(For details, see the GE case study at http://www.gehealthcare.com/centricitybusiness/downloads/ITB-0189-06.11-EN-US_centricity-business-westmed-case-study.pdf)

Operations Automation

Using software to optimize operations helps to increase efficiency and can indirectly improve care quality by freeing up resources to focus on high priority needs. Applications for optimizing patient flow, workforce utilization, and asset utilization help providers ensure that the right clinicians, materials, and patients come together at the right place and

the right time (much like air traffic controllers in a modern airport). This helps to reduce waste and improve patient satisfaction, worker satisfaction, and profitability.

• Operations Automation in Action.
A healthcare provider in England implemented real-time monitoring and management of 32 operating rooms across two hospital sites, which has freed up more than EUR 0.75 million worth of capacity, saved EUR 1 million in materials, and enabled them to use 96 percent of elective theater capacity.

(For details, see the GE case study. <http://newsroom.gehealthcare.com/a-digital-operating-room-could-be-the-piece-that-solves-the-nhs-puzzle/>)

Integrated care applications, such as those described above, lay the essential foundation for automating workflows and for using and sharing data more effectively. Many of these applications

include integrated analytics to uncover actionable information and insights within their particular sphere of operation.

Hosting these applications on a computing platform optimized for data integration and analytics, such as Predix for Healthcare, increases their value. With the ability to combine, filter, search, and analyze all available data—from medical images and clinical notes to patient flows and mobile asset locations—efficiency and decision-making can be improved across the full continuum of care.

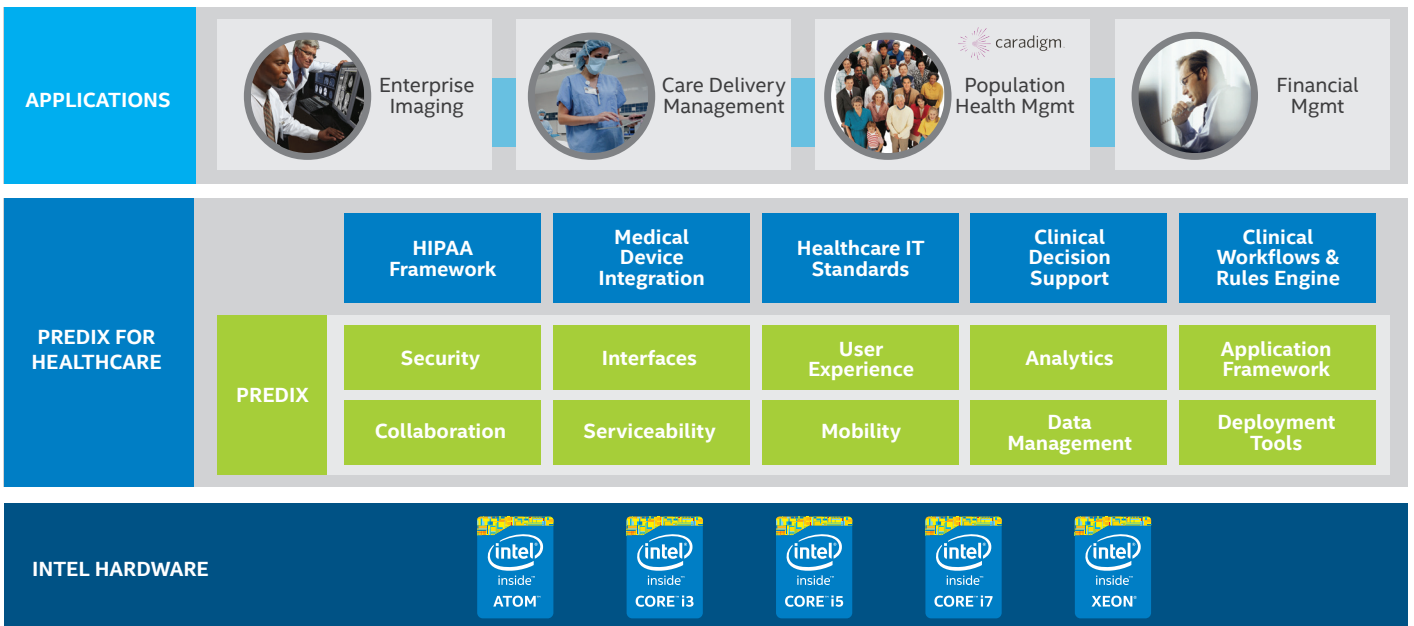
Getting Started

High-Level Recommendations for Healthcare Organizations

It's one thing to have a broad strategy for moving toward analytics-driven healthcare. It's quite another to implement that strategy successfully within a complex, life-critical healthcare network. The best path forward will

Improving Outcomes through Powerful Analytics and Data Sharing

Predix® for Healthcare: A Comprehensive Software Platform for Integrated Care



Intel® Architecture: An Optimized Hardware Platform for Scalable High Performance



Figure 1. Predix® for Healthcare is a scalable, high-performance platform that provides an industry-leading stack of technologies for distributed computing, big data analytics, asset management, and machine-to-machine communications.

be different for every organization. The following recommendations can help as you begin to select, implement, and integrate next-generation healthcare applications and apply advanced, big-data analytics to further improve outcomes. These recommendations are based on work GE and Intel have done over many years with hundreds of healthcare providers.

Target your most critical needs

The place to start is with your most critical needs. Where do the most serious points of inefficiency and risk lie across your clinical, operational, and financial processes? Look especially closely at your most complex and cost-intensive areas, such as operating theaters, emergency rooms, and intensive care units. Consider population health management, as well. It can have a major impact on the overall health of your patients and the total cost of care, by helping you reduce high-cost, high-risk incidents.

Apply proven “industrial” principles

As you move forward to improve your processes, there are proven strategies that have been time-tested across many industries.

• Focus on measurable outcomes.

It's easy to get lost in the details of implementation. Focus on desired outcomes to keep your projects on track and to clearly assess value versus cost and risk. Use clear and transparent measurements that reflect the clinical, operational, and financial factors that are most important to your organization, such as safety, diagnostic accuracy, patient wait times, staff to patient ratios, and claim denial rates.

• Design for quality.

Use advanced design tools to simulate real-world use cases when designing new facilities or restructuring processes and workflows. Involve the people who will actually be impacted by the new designs, including clinicians, financial teams, and operational staff. By putting powerful simulation tools in the hands of doctors and other caregivers, one hospital network developed an innovative new hospital

design that reduced nurse travel time by 20-30 percent and increased direct care time by 20-40 percent.²

• Manage variation.

Unnecessary variation in diagnostic techniques, treatment protocols, and dosages are a clear indication of inefficiency and potential risk. You don't have to impose strict requirements on your clinicians. When you measure and share information, people tend to look, listen, and naturally start improving. A leading healthcare provider found 13-1 variation in CT brain dosages at one of its facilities, and the variation was not justified by any clinical evidence. Simply sharing that information resulted in a 45 percent reduction in average dose and a 65 percent reduction in variation.²

• Implement centers of excellence.

Specialization and repetition drive quality and productivity for complex tasks, yet it can be difficult to create sufficient volume for one deep specialist. Use information technology to enable centralized assets, including specialists, facilities, and equipment, to be utilized more efficiently. The Medical Imaging Antilles-Guyane

(IMAG) group, for example, is rolling out a cloud-based image sharing system, so that radiologists in densely populated areas can support non-specialist clinicians across remote areas of Martinique, Guadeloupe, and French Guyana. The solution will help to improve care for more than a million people. <http://www.genewsroom.com/press-releases/ge-leads-cloud-based-project-improve-patient-care-martinique-guadeloupe-and-french>

• Integrate intelligence that delivers clear value.

Keep complex analytics in the background, where your data, business, and clinical analysts are equipped to handle it. Front line clinicians, administrators and financial teams need actionable insights that are delivered in clear, preferably visual formats. For example, bed placement analytics can help to ensure that patients are placed in the right bed quickly and the first time, so they are in the best position for efficient use of physicians, nurses and equipment. Overlaying information and recommendations on an interactive map of the facility can help admitting staff make quick, accurate decisions.



Figure 2. The new generation of healthcare applications is designed for broad interoperability, which can help organizations break down their data silos and accelerate their move toward fully integrated care and next-generation big data analytics.

Consider the Cloud

One thing is clear. We are all going to need lots more computing power in the future. At least part of the solution will come from taking advantage of cloud-based solutions. Cloud technologies allow the resources of a large data center to be shared among multiple users flexibly and securely. New applications can be deployed in minutes and the data center resources for each application can be dynamically and automatically optimized to meet application requirements at the lowest cost. Cloud solutions also simplify data sharing across organizational and geographical boundaries.



Most importantly, cloud computing delivers efficiencies and economies of scale that have not been possible before. You can combine in-house cloud resources, with those of dedicated private clouds that are purpose-built for healthcare needs (e.g., HIPPA compliant), and more general-purpose public clouds that have better cost models, but less security and regulatory support. By matching your application and data requirements to best-fit clouds, you can maximize value while minimizing your cost and risk.

Conclusion

Big data technologies that search, filter, and analyze massive, complex data sets in fractions of a second are transforming the way businesses compete. These solutions have tremendous potential to improve the quality and efficiency of healthcare delivery, and GE and Intel are working together to deliver a computing platform that simplifies integration into complex environments.

Predix for Healthcare provides an analytics-optimized foundation for healthcare that can help providers combine and analyze all their data more effectively. In combination with GE healthcare applications, it can also help them push the resulting insights back into their clinical, operational, and financial workflows, so decision-makers at every point have better and more complete information. With unified data and increasingly powerful analytical tools, they will have the strategic and tactical information they need to drive continuous improvements in quality and efficiency.

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1 For 31 of the past 40 years, health care costs have increased at a greater rate than the economy as a whole." Source: Best Care at Lower Cost, The Path to Continuously Learning Health Care in America, Briefing Slides, by Mark D. Smith, MD, MBA, Study Chair, Institute of Medicine of the National Academies.

2 Source: GE Healthcare.

3 Today's mainstream server platforms based on Intel® Xeon® processors deliver nearly nine times the performance of comparable 4-year old systems that are still in wide use today. Source: SPECjbb2013 benchmark results as of September 8, 2014. Compares the performance of a two-processor server based on the Intel Xeon processor E5 v3 product family versus a comparable 4-year old two-processor server based on the Intel® Xeon® processor 5600 series. Baseline configuration: Supermicro® X8DTN+ platform with two Intel® Xeon® Processor X5690, Java® Standard Edition 7 Update 11. Score: 21,709 SPECjbb*2013-MultiJVM max-jOPs, 3,587 SPECjbb*2013-MultiJVM critical-jOPs. For details, visit <http://spec.org/jbb2013/results/res2013q1/jbb2013-20130205-00003.html>. New configuration: Hewlett-Packard Company HP ProLiant ML350 Gen9 platform with two Intel® Xeon® Processor E5-2699 v3, Oracle Java Standard Edition 8 update 11. Score: 190,674 SPECjbb2013-MultiJVM max-jOPs, 47,139 SPECjbb2013-MultiJVM critical-jOPs. For details, visit <http://www.spec.org/jbb2013/results/res2014q3/jbb2013-20140902-00101.html>

4 Intel® Solid State Drives (Intel® SSDs) eliminate much of the latency associated with traditional hard disk drives (HDDs), which rely on spinning mechanical disk and are inherently slow compared to silicon-based storage solutions. These high speed drives help to accelerate data flow into Intel Xeon processors to optimize processor utilization and deliver higher overall performance for the data-intensive applications.

5 Medical Center Case Study; November 2010, reprinted January 2015.

6 Helimed Diagnostic Imaging Case Study, March 2014.

7 Kansas City Bone & Joint Clinic Case Study, "Driving Up Volume," December 2012.

8 TechValidate Survey, April 2014.

