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9-614-032
REV: MARCH 9, 2015

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GE and the Industrial Internet

We are the oldest remaining company in the Dow Jones Industrial Average. This is not because we are a perfect company; it is because we adapt. Through the years, we have remained productive and competitive. We have globalized the company, while investing massive amounts in technology, products and services. We know we must change again.

— Jeff Immelt, CEO, General Electric[1]

General Electric (GE) CEO Jeff Immelt (MBA 1982) sat in his office with Chief Marketing Officer Beth Comstock and Vice President Bill Ruh, head of the new GE Software business unit. It was early 2014, and they were reviewing the latest report of completed and potential customer contracts for GE's new Industrial Internet initiative. Now a little over two years after announcing the initiative and betting more than $1 billion on its rollout, GE could already directly attribute over $800 million in sales to the effort. Yet these numbers represented only a tiny portion of GE's annual revenues—close to $146 billion for 2013. Immelt and his team worried: Were they doing enough to give the initiative traction within GE? Could GE, an industrial machines manufacturer, sell outcomes-based services based on analytics and software?

GE's Industrial Internet initiative proposed an open, global network that connected machines, data, and people, and provided data synthesis and analysis allowing for real-time and predictive solutions to optimize the complex operations of GE's varied customer base, including predicting maintenance and repair needs and informing performance and operational decisions. GE's suite of Industrial Internet offerings was designed not only to create and sell "smart" software–enabled machines but also to provide outcomes-based services contingent on improving operational performance via data collected and analyzed in cooperation with customers. Wall Street and technology analysts projected that the Industrial Internet (also referred to as the Internet of Things) would generate tremendous value in both increased revenues and decreased costs. Analysts estimated the Industrial Internet would create $14.4 trillion in economic value between 2013 and 2022.[2,3] By that time, they projected that Industrial Internet–related technology spending would exceed $514 billion.[4] Some GE customers were already seeing benefits from their connected machines. For example, improving airline engine efficiency by 1% equated to $2 billion in annual savings.[5] Integrating dispatcher data with customer data improved a carrier's package delivery by 10.4%.[6] (**Exhibits 1a and 1b** provide examples of potential savings; **Appendix A** describes the Industrial Internet.)

Professors Karim R. Lakhani and Marco Iansiti and Case Researcher Kerry Herman (Case Research & Writing Group) prepared this case. It was reviewed and approved before publication by a company designate. Funding for the development of this case was provided by Harvard Business School and not by the company. Professor Karim Lakhani has previously worked at GE. He has also taught at GE Crotonville and has had several consulting engagements with the company. Professor Marco Iansiti has also consulted to GE. HBS cases are developed solely as the basis for class discussion. Cases are not intended to serve as endorsements, sources of primary data, or illustrations of effective or ineffective management.

Since announcing the initiative, GE had seen intense changes in the past 12 months, including the build-out of a new software headquarters; the launch of a common technology platform across GE's diverse industrial businesses; a thorough assessment across the organization of GE's software development expertise and readiness evaluation of its sales talent capable of supporting this new direction; and new and expanded partnerships with companies such as Intel, Cisco, and Accenture.

GE had signed several promising agreements, including a $300 million contract with a utility company, a reliability-based service for an oil and gas customer for $20 million, a wind farm deal for $35 million, a $100 million deal with a U.S. hospital chain, and a possible $1 billion rail deal. A GE/Accenture joint venture, Taleris, which provided intelligent operations for aircraft and cargo carriers, had also just announced its first signed customer, Etihad. These agreements offered a range of benefits, including a monitored rate of flow on oil rigs, optimized wind turbines to adapt to changes in weather, optimized patient intake at hospitals, and predicted replacement of air conditioners in a fleet of aircraft in order to avoid downtime. Each deal was highly idiosyncratic, relied on deep familiarity and expertise with the specific customer and its sector, and required GE to be innovative and customize how it partnered with the customer and sold the software-enabled, outcomes-contingent offering. Many of these deals also required customers to allow significant access to internal operational data and some kind of value/revenue/profit-sharing arrangement, in contrast to GE's more traditional contract service agreements.

Immelt felt the initiative was an opportunity that GE could not afford to ignore. Global Innovation Executive Director Steve Liguori said, "We have new non-traditional 'competitors' starting to approach our long-standing customers. IBM mostly, but SAP and big data start-ups are telling our customers they can provide these analytics and services, on *GE* assets." Comstock added, "Our customers are under intense pressure, given the ongoing uncertain economic environment. We're not selling as much hardware ourselves." Immelt and his team had to ask if GE's customers were ready for the Industrial Internet. In October, GE had taken an informal poll of customers about their readiness and adoption of the Industrial Internet and learned that 63% of customers polled said their machines were connected to networks, but they were not yet using these data, 13% claimed they used data for competitive advantage, and 63% were not performing any condition-based maintenance.[a7]

Internally, debates remained heated over which business model the initiative should pursue. Some argued that GE should develop software capabilities and give them away for free as part of an intensified focus on capital equipment sales and service contracts. GE Software Chief Marketing Officer John Magee said, "In the past, our mentality was to build and ship boxes. Any software we had was often given away as part of a hardware sale." A second camp saw opportunity in the software capabilities themselves and argued that GE should license these offerings as a separate product. Finally, a third camp argued that GE should embrace the initiative and pursue software and analytics investments that enabled new, outcomes-based service offerings that would mean rich, deep integration with GE customers and their data.

Pursuing the third option meant a host of changes. Magee said, "This initiative creates brand-new business models for us. Software as a service represents a whole new beast for GE." GE had to identify and develop new opportunities, source and hire developer and sales expertise and talent, build the offerings, and price and coordinate sales of each offering through each division's sales mechanisms. Liguori added, "At GE, 99% of our sales force sells 'big iron.' They are used to selling capital goods versus gain share or revenue-share arrangements with our customers. They are used to

[a] Condition-based maintenance referred to maintenance undertaken when needed, due to indicators that alert to either the deterioration or potential failure of equipment or system.

talking to operations managers who run the plants that our equipment is in. Now we need to expand our message to the entire C-suite, showing how we can help run all their assets and, ultimately, their enterprise better." The Industrial Internet called for a different approach. But what levers could the team pull to accelerate the initiative? Immelt was well known for his metrics-driven management; which metrics had the most impact on GE's ability to speed up the initiative? Immelt turned to Comstock and Ruh and asked, "Are we moving fast enough? Can we be faster in this or not?"

Company History[8]

Thomas Edison founded General Electric in 1892 after the merger of Thomson-Houston and Edison General Electric. Edison set the company on a long trajectory of innovation. He amassed over 2,000 patents with inventions such as the phonograph, the radio, and the incandescent light bulb, along with the capability of generating and transmitting the electricity to electrify them.

Through the 20th century, GE manufactured products and provided services across a broad range of industries, including aircraft engines, locomotives and other transportation equipment, kitchen and laundry appliances, lighting, electric distribution and control equipment, generators and turbines, and medical imaging equipment. By 1980, GE earned $25 billion in yearly revenue from plastics, consumer electronics, nuclear reactors, and jet engines.[9] Through the 1980s and 1990s, GE shut down underperforming businesses and diversified, investing more heavily in financial services and entertainment. As it diversified, GE looked less like a traditional industrial company, with profits coming increasingly from its financial services offerings, which included commercial finance, commercial aircraft leasing, real estate, and energy financial services. By the late 1990s, analysts identified the increased sales of service contracts as a contributor to GE's increased profits.[10] From year to year, under CEO Jack Welch, GE looked for ways to "go downstream,"[11] pursuing a comprehensive services business model that offered a range of ancillary services to its industrial products, tying the customer more closely to GE.

GE under Immelt

Immelt took over as CEO of GE in September 2001, just days before the September 11th terrorist attacks in the U.S. Immelt recalled his first weeks as CEO: "It was super intense. I was not cool at all."[12] Immelt had joined GE in 1982 in corporate marketing, moving from there into leadership positions with GE Plastics and then GE Appliances. He was president and CEO of GE Medical Systems from 1996 to 2000, where he increased its share of service business from 25% to 42%.[13]

By the early 2000s, GE was operating in a changing world, as Immelt noted, "In a deflationary world you could get margin by working productivity. Now you need marketing to get a price."[14] As he pursued a more service- and customer-oriented organization, he brought in Comstock in 2003 as GE's first chief marketing officer in 20 years. Immelt and Comstock built an entire new marketing function for GE, recasting many of the firm's extensive business development talent as marketers; developing a new leadership program (Experienced Commercial Leadership Program) to parallel GE's traditional offerings in engineering, finance, manufacturing and sales; and appointing a vice president–level marketing head for each business.[15] In 2003, Immelt set up and personally chaired a Commercial Council to convene sales and marketing leadership across the company to transfer best practices and accelerate initiatives throughout the organization quickly. To track his teams' success with customers, he relied on two metrics: a net promoter score[b] and an operating metric best suited to each business.

During Immelt's reign, services continued to grow as a portion of revenue. By 2005, contract service agreements (CSAs) made up about three-quarters of GE's total backlog[c] and contributed about 75% of industrial earnings.[16] CSAs were regular maintenance agreements for the total operation management of an asset. They included preventative maintenance and fixes, essentially "break-fix" insurance; when an industrial product—a machine—broke, GE fixed it. CSAs provided flexible service packages designed to meet a customer's specific requirements, goals, and budget to ensure optimum performance of GE's equipment, stable operating costs, and planning for spare and replacement parts. As Magee explained, "CSAs evolved into turn-key, long-term, recurring revenues streams for GE," generating reliable high-margin income that lasted the life of the piece of equipment, often several decades.[17] (See **Exhibit 2** for an evolution of GE's service model over time.)

Immelt also looked to focus GE on its strengths and opportunities. He spun off businesses that did not fit, including GE Plastics, many of its financial services and insurance businesses, and NBCUniversal, while he grew some of GE's traditional businesses through acquisitions. In 2007, GE acquired an aircraft systems manufacturer and an oil and gas production equipment supplier. GE continued to invest in the technology needed to gather, process, and use the information generated by its machines and, by 2010, had over 5,000 software engineers worldwide, with two newly opened software centers near Detroit, Michigan, and Richmond, Virginia.[d] Revenue from software reached $2.5 billion (of $150 billion).[18] As the first decade of the millennium came to a close, GE continued to consolidate and focus on its customers' core needs.[19] (See **Exhibit 3a** for details on each business unit; **Exhibit 3b** provides financials.) In September 2013, GE reported a backlog of $223 billion, equivalent to more than a year and a half of company revenues. Service contracts continued to make up about three-quarters of the backlog, and services still contributed about 75% of industrial earnings.[20] (See **Exhibit 4** for a comparison of services and products.) In 2013, software and software-enabled services contributed about $4 billion annually to GE's total revenues.[21] And in August, the company announced that it would spin off parts of GE Capital in one form or another in 2014, reflecting Immelt's continued commitment to strengthen GE's industrial side and his pledge that by 2015, 65% of GE profits would come from industrials.[22]

In 2013, GE's scale and scope meant that literally billions of its devices and machines were spinning in operation around the globe. Total assets of global operations on a continuing basis were $337.6 billion in 2012. GE produced aircraft engines, locomotives and other transportation equipment, kitchen and laundry appliances, lighting, electric distribution and control equipment, generators, turbines, medical imaging equipment, mining equipment, oil and gas equipment, along with a host of commercial finance, insurance, real estate, and energy-leasing products, touching virtually every corner of the globe.[23]

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[b] Net promoter scores measured the percentage of people who said they would recommend GE to a friend, minus those who would not..

[c] Backlog referred to the value of unfulfilled orders.

[d] The Virginia center, opened in 2011, focused on cybersecurity; in 2009, GE launched its advanced manufacturing-software center in Michigan, focused on avionics and jet engine production, and internal production improvements. See Kate Linebaugh, "GE Makes Big Bet on Software Development," *Wall Street Journal,* November 17, 2011, http://online.wsj.com/news/articles/SB10001424052970204517204577042532750345206, accessed January 2014.

The Industrial Internet: A New Opportunity?

With the early Internet, we never imagined the implication of a billion people being connected, so when 50 billion machines become connected . . .

— Bill Ruh, Vice President, GE Software

Sizing the Opportunity

The Internet of Things encompassed all connected devices—from consumer to industrial. Cisco estimated that there were about 9 billion connected devices in 2010 and that the number would grow to 50 billion by 2020.[24] Quantifying the size of the Industrial Internet was challenging, with microprocessors, sensors, and other software components already embedded in most industrial assets. One industry player expected the Internet of Things to create $14.4 trillion in economic value between 2013 and 2022; another expected that $1.9 trillion of economic value would be added in 2020 alone.[25] Others pegged the value of Industrial Internet–related activity at about $23 billion in 2012, with growth projected to hit $1.3 trillion by 2020.[26] These analysts projected Industrial Internet–related technology spending to reach $514 billion.[27]

By 2011, GE's assets also had significant embedded software, along with sensors and microprocessors, running power plants, jet engines, hospitals and medical systems, utility companies, oil rigs, and rail and other industrial infrastructure worldwide. GE predicted that smart components would save the oil and gas industry more than $90 billion a year through reduced operating costs and fuel consumption,[28] while improved resource usage and tracking and status of equipment could save the health-care sector $63 billion from efficiency gains (see **Exhibit 5a and 5b**).[29] GE projected that efficiency gains as small as 1% could have huge benefits over time when scaled up across the economic system (refer to **Exhibit 1**).

The decision to build an Industrial Internet never gave Immelt pause; he explained, "I have a great deal of confidence in our core hardware. We have the most stuff. It's hard to replicate. We started from a real position of relative strength." It was GE's huge scale and massive installed base that could speed its vision of the Industrial Internet to reality. As one GE researcher noted, "We have some of the biggest industrial data sets, because we've been operating this equipment for a long time. . . . We have the before and after and can test any algorithm and see how it works."[30] The analytic applications GE could build using these data could qualitatively enhance a customer's business. In 2009, GE Transportation had released software that railroads used to calculate the weight and length of a train, topography, speed limits, and other variables in order to avoid unnecessary braking, saving an average class-1 U.S. rail company $150 million annually in fuel savings.[e] According to one GE insider, with over 400 data points collected continuously in one wind turbine, for example, or tens of thousands of data points in one wind farm, "We have an opportunity, as we think about reliability, availability, and performance, to use that data to come up with better product and service offerings and get more out of the existing fleet [of wind turbines]."[31] Describing the opportunity, one observer wryly noted:

> Not only is GE allowing a zillion smart-machine flowers to bloom, but its vision is to use the data from these machines, not in isolation, but in aggregate to create value for its customers and improve the lives of individuals, corporations, governments and humankind in general. That's big. Supply chains. Health. Instrumenting infrastructure. Supporting the build out of massive cities in growth regions. It's mind-boggling big.[32]

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[e] This assumed 10% fuel savings, $75,000 per locomotive per year, and 2,000 locomotives for an average railroad company.

Collectively, GE's various business units employed over 8,000 software professionals that helped generate several billion dollars in software revenue alone. However, there was no overarching strategy guiding their technical choices and commercial offerings. Thus, each business unit and even each product leader optimized software choices to the local conditions, resulting in significant heterogeneity in technical and commercial success. The Industrial Internet initiative required new types of software technology and required a more coordinated approach. The advent of cloud computing added more opportunities and threats. As the scale and scope of the Industrial Internet opportunity across GE's businesses became clear, two things became evident to headquarters staff: GE needed a global software center to develop and support emerging software applications uniformly across the businesses and needed new and innovative approaches to managing customer relationships, including how to sell and service the new offerings.

How to Build an Industrial Internet: GE Software

Based in San Ramon, California, and headed by Ruh, the inception of GE Software was first announced in November 2011 as a part of GE's Global Research Center (corporate research and development laboratories). Ruh explained, "Co-location is everything. Distributed software development in my view doesn't work, although we still do some. Our fastest-developing programs are in one place. New things are easier to create a team around when they are all in one place." GE Software was funded by Immelt and GE's Global Research, and did not have its own profit-and-loss statement (P&L). Immelt had very specific criteria for GE Software's leadership; as Ruh recalled, "They wanted someone with a background in innovative software development; someone who was service oriented versus product development; and someone able to manage a start-up–like environment in a very large, complex company." Ruh had had a long career in software, working closely with federal agencies early on to build systems that transmitted images from space and tackling early digitization problems. He had focused on secure integration of large business-to-business systems and had worked in analytics at the Central Intelligence Agency. He gained expertise in large systems-based networking at several large companies, eventually landing at Cisco, where he helped create products around new services and eventually ran service product management for all of Cisco as the chief architect of advanced services.

By mid-2011, Immelt had attracted Ruh to head GE Software. "They made it clear this was not about building product," Ruh said. "To do this right, they said, 'You have to understand our service business.'" Ruh started out as the sole employee, with a temporary office in San Ramon. (See **Exhibit 6** for map of the region.) He hired designer Greg Petroff early on to head user experience (UX) for GE Software and tasked him with developing a system that could bring all of GE's machines "onto one cloud-connected, contextually aware, super-efficient platform."[33]

By January 2013, Ruh had hired 62 employees, and by June, about 150 employees moved into the new offices.[34] By the end of 2013, Ruh expected to have 350 employees, with transfers from other parts of GE making up less than 2% of his team. Chief Technology Officer Mark Little, senior vice president, director of GE Global Research, said, "Bill Ruh was one of the few with the domain expertise and leadership who could come into this big complicated company and move us from the notion of doing something interesting and put us on a well-defined path. It's remarkable how far we've come in the few short months he's been here."

Ruh and senior leadership focused GE Software's next task: getting a handle on the scope of GE's existing software globally, most of which was embedded and customer-facing, and the developers behind it. Ruh said, "Every one of our products had a different underpinning platform, architecture, technology, and set of vendors." A survey of the 136 existing GE software offerings revealed further complexity. He added, "Only 17 of our software offerings were generating profits. We began to look at the problem: it was taking us years to build the software, and years to get it out the door. And customers' needs were changing too rapidly to keep up. An additional problem was that a large percentage of the development cost was being spent on aspects of the core platform rather than on the application itself."

An example from the Oil and Gas business unit illustrated the challenges. Everything on an oil rig was monitored locally, on the rig. "That's where the data is," said Paul Rogers, GE Software head of software development. A customer approached GE about developing a tool that could monitor some underwater switches remotely, via the cloud. The customer requested that Oil and Gas engineers develop a simple tool to measure when a sensor was on or off, saving a physical visit to each rig to collect the data. The engineers made a proposal and promised product delivery within 18 months. Three years later, there was still no deliverable, and the vision for the product had expanded to incorporate 5,000 "cool" features, Rogers recalled. The group came to Ruh and his new team at GE Software asking for help. In three months, the team had a low-cost solution. Rogers said, "The project they were originally working on didn't even have the customer's initial vision in it. They thought that was too boring. There's a legacy mind-set here that 'It can't be valuable if it's not hard.'"

Developer talent had to be addressed. Ruh explained, "Our software engineers had experience in one of two ways: they were either mechanical engineers or they were computer scientists. But most of them had experience with technologies that were last generation. They were very reliant on outside vendors, sometimes for full development. And when you're building products and services, you have to own the intellectual property, or IP." Further, there was no common language among the ranks of GE's existing software experts. Brad Surak, general manager of Industrial Internet Programs at GE Software, said, "In other organizations, you may not agree, but you speak the same language. Here we didn't even speak the same language." Finally, many at GE were skeptical about moving services and capabilities to the cloud, which the initiative would rely on extensively. Immelt immersed himself in the technology behind GE's platform. His familiarity with the pros and cons of the cloud "allowed us to move a lot quicker," said Surak. "Software at GE had a culturally different feel than the world of applications [apps] and services we were trying to move into. It was a bit more conservative. We faced a lot of difficulties convincing people that moving some of our capabilities to the cloud was important. So Immelt's engagement and support was critical."

As they moved past this initial assessment, Ruh and his team found that some GE businesses were more ready to collaborate than others. The businesses were huge and global, often encompassed many smaller acquisitions, and had a history of autonomy. Ruh added, "We were not here to force everybody. I said, 'We're going to do this, you can be on the train or not.' There were a number who wanted to, so we developed them at a very fast pace and got them successful quickly. They were visible to other executives who then asked their own businesses, 'If you're not doing this, why are you not doing this?' And there was no good answer." Magee added, "It couldn't be a 100% mandate, we had to take a subtle approach. We don't have a stick, only carrots."

Getting to a Common Platform

Integrating the new offerings across GE and its customers in a coherent and intelligent way presented another challenge. Some business units, like Healthcare, had thousands of different products, machines, and devices, each with its own complex software needs and legacy systems. Ruh said, "We realized early on that our user experiences, or user interfaces, were different on every product, even products in the same groups. Sometimes you didn't even know if it was a GE product." Ruh's team had to determine how to develop a single platform for all of GE's business units and created a design team to address this issue. Ruh said, "I knew we had to put a single, common platform in place, then be sure everyone was able to build on it."

A common platform would enable GE Software to develop a common language and common practices across the businesses, despite the widely varied industries and customers they all served. The platform would have to meet a number of requirements, such as providing mobility, ensuring security and compliance, providing a seamless user experience, connecting GE's machines, and managing distributed computing and analytics, all in the cloud. Magee noted, however, "A common platform was pretty radical, given how GE was characterized as being so separate and silo-ed. We can't do this alone." Ruh involved all the businesses' technology architects in developing the platform, although his efforts were not funded directly by the businesses.

The significant decision, however, was to let each business unit continue to maintain its existing platforms and services while developing an underlying platform that could provide the hosting ecosystem for GE's ongoing software services, and to create a uniform user interface while enabling the very different industry-specific environments and data and analytics needs. Magee noted, "Owning and building the platform here was critical, but it's also important that we decided it should be a middleware platform that didn't dictate software decisions to the business units, but rather helps teams get products out faster."[f]

However, Magee acknowledged, there had been extensive debate about how open the platform should be. He added, "Should the platform be open? Or a GE standard? It's to our benefit to create an ecosystem for everyone's assets to share data."

Taking an Industrial Internet to Market

While Ruh and his team pushed forward on GE Software and the common platform, Immelt and Comstock considered the challenges and opportunities that the new offerings meant for GE's marketing and sales. From the outset, some thought selling analytics and other software offerings went beyond GE's scope; others thought licensing the offerings was a cleaner model to pursue. Magee speculated, "There is a point at which someone might give generators away for free, and rather monetize the services and data coming out of that generator." Immelt added, "The transition we're going to have to make with our customers is going from agreements that are break-fix into agreements that guarantee outcomes. Those are going to happen customer by customer, and the outcome guarantees are going to cannibalize the break-fix."

Strategies for getting GE's Industrial Internet offerings to market had to be clarified. Magee elaborated,

> There are new commercial- and consumption-based business models emerging. On the commercial side, there's the Industrial Internet as a service, which could include a range of things including remote monitoring and diagnostics, information services, platform-as-a-service (PAAS), or data management. On the consumption side, there's outcome-based solutions, gain share, risk share, and even flexible service contracts. But we believe it's about analytics, not about selling licensed services. We're not Microsoft. It's a different consumptive model.

[f] See also "The Case for an Industrial Big Data Platform," http://gesoftware.com/Industrial_Big_Data_Platform.pdf.

Comstock added,

> Given these opportunities, how fast do we scale it? How do we sell it? We have two cultural imperatives: an outcomes-based world versus selling machines. GE grew up in a linear, processed-based, machine-selling world, and that world parallels our customers'. How do we get our customers to be more outcomes based rather than just sell them things? How involved do we get in educating them? And internally, what capabilities do we need to build out in our sales force?

Some were concerned that the offerings would cannibalize GE's existing industrial machine sales. The trade-off was between selling more equipment or hardware and selling less hardware with some software. One insider noted, "Embedding the software in an existing sale gets away from some of that, as with the CSA, but it also has the downside that you could end up having to give more away than you expected because of the nature of that sale." Increasingly, hardware was becoming commoditized across all of GE's sectors, putting additional pressure on the CSA model. Others argued the predictive services were really just enhanced CSAs and should be sold as CSAs with added value. But embedding the software in an existing service or bolting it on to extend a CSA changed how it should be sold and had implications in the investments the GE's sales organization made. Immelt added, "We'll still capture some of the value created before; it's just going to raise the risk/reward equation. I don't think we're going to have to throw everything away, but I think we're going to have to bridge from one set of agreements to another, where you're going to run some risk because what was assured before is going to have more upside, but more performance guarantees alongside it."

As GE Software identified the opportunities and capabilities needed to develop them, it was clear the business units' sales and delivery capabilities had to grow and shift. Selling capital expenditure goods, such as GE's spinning machines, had a long sales cycle, running from 3 months to as long as 18 months, depending on the device. The CSA was typically negotiated at the time of sale, with repairs and maintenance supported by GE's army of service personnel. Renewals and extensions were negotiated as the CSAs expired, sometimes by a separate sales force.

GE's traditional sales process would have to adapt to accommodate a range of new offerings, customizations, customer relations, and services. Magee noted, "There's a great deal of organizational change needed to put the right people into the right place. Not just in development, but in bringing these offerings to market." Delivery presented challenges as well; Magee added, "As we see the cloud taking hold and playing out in the industrial sector, customers want to pay for what they are using. They want to dial down or up based on their needs."

Product, Price, and Sales

Selling the offerings presented a number of possible business models. From early on, many thought GE should package and license its software offerings; Ruh acknowledged, "The initiative presented huge challenges in terms of monetizing. Lots of people were asking, 'Should we license?'" The breadth of individual machine data points was enormous across all of GE's assets; each data point offered information about performance or opportunities to improve efficiencies, optimize performance, or otherwise better understand overall operating needs. But how to quantify these efficiencies was not yet clear. Ruh added, "Fuel savings can be monetized, but how would we monetize productivity? Some of these things are very hard to measure." He elaborated:

> You have an existing service business; do you bundle it with an existing service to add enough value, or does the customer want it for free and you get nothing for it?

> That's a decision to make. There are reasons to do it for free, where you're extending the value of what you already have because the margins might erode. Or do you have a stand-alone service? That would have implications in terms of how you sell in investments and sales. Or you might take it out externally because what I sell and how I sell is either a little bit in conflict or I'm never going to get good enough fast enough at it. We've learned you've got to be really sophisticated on the monetization and go-to-market on this.

As each business had varying degrees of software already embedded in its products or included differing ranges of services through software, Ruh and his team faced challenges in helping businesses refine and focus their product offerings, especially those businesses that had acquired capabilities. "Dealing with the acquired capabilities in particular created significant complexity," Ruh noted. "In certain cases, our credibility in the market had been defined by those acquisitions—sometimes negatively. So we had to make sure those acquired capabilities would not undermine the perception of what we were capable of achieving."

Pricing the outcomes-based services presented a challenge, along with the question of how and to whom GE would sell the new offerings. Ruh noted, "The buyer is changing within our customers' organizations. Typically, the COO has been the ultimate decision maker. But we're also witnessing a shift in where the decision-making power lies, as cross-functional stakeholders become a part of the process. Increasingly, the CIO now has a vote, asking very valid questions like, 'How is this going to integrate with what I have in place?'" Magee added, "Some instances require provoking the customer and putting us in a position to say, 'You may need to do things differently in your business in order to gain the benefits. We have an opinion about this.'"

In addition, the sales approach had to change. Ruh explained:

> We need to move away from a traditional "box seller" mentality and toward a solution-based sales methodology focusing on the customer's pain points. Before, we targeted an existing budget line item, but, if you're promising to save fuel burn costs, a budget line item doesn't exist for that, posing a problem for the box seller. So the idea of diagnosing customer needs, establishing value, understanding consumption models, and applying provocation-based selling are very important.

Finally, connecting machines and sharing data raised questions of security and compliance, especially as regulations varied widely across the U.S., Europe, and the rest of the world. GE's experiences with customers' data could lead to efficiencies and optimization; they could also offer opportunities to learn more about a customer's pain point or an industry's inefficiency. But, the intellectual property of those discoveries belonged to whom? Additionally, many of the services GE offered were mission-critical for its customers—whether accurate readings of rail line use or monitoring temperatures in an aircraft's engines—and some worried about liability and level of guarantee.

In August, Immelt brought Kate Johnson in as chief commercial officer, a new position in GE's marketing function. Johnson, with deep experience in selling and servicing enterprise software at companies like Red Hat and Oracle, aimed to build GE's new software sales capabilities. Her first questions were, "What problem are we trying to solve for our customers? How should we engage with them in a way that drives mutual success? How is this different from what we are doing today?" Johnson would oversee a new central function—a commercial center of excellence—that would build sales capabilities to match the initiative's offerings, providing presales resources, an enablement engine, and postsales support.

Making Headway

Not everyone in GE was convinced about the initiative. Some GE businesses were better positioned than others for the types of offerings GE Software might develop. Ruh explained:

> The easiest and quickest beneficiaries have been GE businesses with minimal existing software-based services in their portfolio and, as a result, had fewer software development organizations with a vested interest in legacy technology. Aviation, for example, has been a great partnership for GE Software. We have multiple programs in place and are zooming along; Oil and Gas is also making significant strides. Healthcare, in contrast, is taking a bit more time to switch over as they navigate the complexities of their current software business, which is not seamlessly integrated.
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> We also had to overcome barriers created by the traditional accounting treatment of software development in the businesses. For certain organizations, software development had been capitalized over the useful life of the software itself, which helped reduce and normalize expenses over time. However, a shift in technology in that model can require a write-off of that asset, creating an undesirable financial consequence to the business.
>
> Another challenge was the changing paradigm of software development. We were moving to the agile and extreme programming paradigm, bringing us significant time-to-market and productivity benefits, but requiring new and different skill sets. So it was sometimes hard to move them off of the old technology and onto the new.
>
> We decided we would start by working with those organizations within GE that could rapidly change and that had the means to do so at Internet speed. When others started to see the instant transformation of their peer businesses operating smoothly, they couldn't move fast enough to get on board. In essence, that peer pressure created a domino effect across GE.

tenX

As GE Software began to get traction, Ruh's team turned its attention to work on a platform and customer interfaces, and to decide which of GE's promising offerings to prioritize. One insider noted, "GE has visibility into cost of delivering service, down/up time, for industries like aviation, transportation (rail), oil and gas, and power generation." Ruh and his team developed tenX, a portfolio analysis process to help understand what untapped opportunities already existed across GE's industrial businesses. (**Exhibit 7** shows a sample tenX process.) tenX helped each business evaluate its portfolio, identify what was new and what presented a viable opportunity, and determine whether it had the right software resources behind it. Ruh explained, "We call our methodology tenX to instill a concept away from incrementalism. We should be offering something that's worth 10-x of value. There has to be something with big enough value in the offering, where the savings was enough and we can give a fair price. We used tenX to say, 'OK, what's something you could create that if you took only 10% of the value, would it still be a home run?'"

The tenX portfolio strategy engagements informed a narrower focus on priority products and helped clarify the range of metrics that GE Software could track to get a reading on indicators of future growth. Magee noted, "We spent a lot of time thinking about segmentation. Can we get more discipline? We'd find smaller things, some opportunistic, but they had to make sense for the business. It wasn't just about finding technology to 'throw over the wall'; we were also always thinking about commercialization."

Once new offerings were identified, GE needed to have the right talent on hand to build them. GE Software's Head of Human Resources Jennifer Waldo admitted, "We are still faced with the challenge of educating our target talent pool on GE's software strategy and initiatives related to the Industrial Internet. We have incredible brand recognition across the eight industry segments we operate in. But much of the software talent we recruit isn't aware that we have a large presence in San Ramon, and doesn't associate our brand with creating innovative software solutions." Additional challenges for GE Software's hiring efforts included meshing software talents' compensation expectations with GE's compensation structure. Waldo added, "Recruiting in Silicon Valley and the broader Bay Area is extremely competitive, and we've had to adjust our compensation and benefits to be successful. A highly competitive job market, compounded by the fact we are a newcomer to this space, has pushed me to be really creative in my approach to hiring."

Building Momentum

To help get buy-in from the top down, Immelt relied on several of GE's councils: the Software Council, the Service Council, and the Commercial Council.[g] The Software Council and the Service Council met to make portfolio decisions concerning the initiative. Ruh reported:

> We created and shared dashboards, which highlight the big winners. By definition it also shined a light on those who opted not to participate. Over time, the tune changed from, "I'm not quite sure of the impact this will have on my business," to "My business will benefit, if I do this successfully." This strategy was extraordinarily important, as it enabled us to have more in-depth conversations on the portfolio road map, as well as demonstrate the potential revenue generation of what we would build.

To drive this momentum across all levels of the business units, GE Software supported internal websites to build community and "make people feel a part of GE Software," as Magee said. GE Software also held a conference in San Francisco and shared a strategic road map for development.

GE Software was measured on the same metrics as the business units, as Ruh noted; that is, growth of the service business and dollars per installed base. Ruh explained the benefits of this arrangement, "I'm not a P&L. So I do not compete with the businesses. I do not get confused by trying to build my business versus theirs. I'm tied to and care about their P&L because I am aligned to the question: 'Did we have business impact?'" He added:

> I don't have full control over the individual business's funding decisions. However, because I do have full control over delivering these software capabilities to them, I can ask, "Are you going to monetize this? Are you going to monetize it the right way?" I can ask uncomfortable questions, and we can have a dialogue. The Software Council makes this all visible. There's nothing hidden, so you have really honest dialogues and can ask: "Are we moving fast enough? Are we doing the right thing? Why aren't you doing this?"

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[g] GE's councils dated back to Welch's tenure and brought together top senior executives and experts from across GE's businesses to explore new issues and share best practices. They often reviewed and approved special projects.

Predictivity and Predix: Getting Early Wins

In November 2012, GE Software rolled out its first set of solutions under the Predictivity brand, GE's first-ever uniform product offering and brand that ran across all its businesses. Predictivity offered a "family" approach, as Magee termed it, providing a common set of data and analytic solutions that could be leveraged by customers in diverse industries. As Magee said, "The industries may look different, but we believe there are many common requirements."

Predictivity included solutions for asset and operations optimization, most prioritized through the tenX process, from across the business units. (See **Exhibit 8** for a usage example.) An asset-optimization product, it enabled power plants to react to real-time changes in power demands, grid conditions, and fuel supply, dialing up or down the amount of energy needed and where it came from.[35] PSEG, a New York– and New Jersey–based utility, used this solution to increase output by 6%, reduce fuel burn by more than 1.5%, and increase operational flexibility for its gas turbine fleet.[36] In health care, a sample operations optimization product integrated bed assignment, departmental workflow, patient flow, transport, and equipment management to reduce wait times and allowed hospital staff to deliver more-efficient quality care throughout a patient's stay. One customer, St. Luke's Medical Center, saw a 51-minute reduction in bed turnaround time and reduced patient waiting times.[37] One of the network optimization products used analytics to give real-time access to critical information so railroads could move more freight faster and more intelligently. One customer saw improvements that included a 10% increase in network velocity, a 50% reduction in expired crews, and significant on-time performance improvements.[38] An airline using GE's software to better track, analyze, and adapt its flight routes and fuel consumption predicted $90 million in savings over five years.

Predictivity solutions combined industrial equipment, Internet-linked sensors, and software to monitor performance and analyze big streams of data, adding to its stable of 10 similar industrial offerings. The Predictivity offerings ran on Predix, GE's common software platform that aimed to dramatically streamline monitoring and maintenance for all of GE's industrial technologies.[39] It combined a set of technologies for distributed computing and big data analytics, asset management, machine-to-machine communication, and mobility. It enabled asset and operation optimization by providing a standard way to run industrial-scale analytics and connect machines, data, and people. It would eventually connect all GE's machines to the cloud, enabling them to talk to each other, learn from historical data, and provide predictive information to help eliminate unplanned downtime. GE expected to open the platform to third-party partners and developers in 2014.

As they worked through the various businesses' existing software elements, GE Software's teams also revamped and modernized interfaces, and created a UX tool kit. Given the myriad of machines across each industry, and the types and amount of information collected, the teams found that the underlying architecture and platform could remain the same for each business. But they had to create a customized software layer specific to each line of a business's needs. (See **Exhibit 9** for a schematic illustration of the platform and overlay software.) The more machines became connected, the more their intelligence evolved based on the embedded software. Ruh explained, "What differentiates us is the ability to have distributed processing across a fleet of machines, to wirelessly connect to those machines anywhere, anytime, and the ability to make machines more intelligent to deliver better outcomes. We had to create those capabilities from first principles."

GE Software also supported some of the various business units' software needs while building the initiative, including development; shared services; strategic alliances, investments, and private equity activity; human resources; and intellectual property concerns. Rogers oversaw development at GE

Software, including the platform, and all new offerings. GE Software's financial head worked with each business unit's chief financial officer (CFO) to map revenue streams. Rogers and Surak also coordinated teams of developers for new product lines in the business units. Ruh took a mixed-model approach to developing and supporting the offerings. Some products represented ongoing or legacy offerings and services, so those stayed with the business unit and Ruh's team helped them hire, manage with the right infrastructure, and create shared services as needed. These developers reported back to their businesses, but they worked with GE Software's teams as a unit. In other cases, the businesses told Ruh and his team to hire developers and manage them. Ruh said, "We are essentially an extension of their business. But it doesn't look or feel any different whether they hire them or we do. We have 13,000 developers around the world creating software to support our global businesses, which provides us with substantial leverage across a broad range of software development capabilities."

An Evolving Sales Process

In parallel, Johnson's team—the new Commercial Center of Excellence—had crystallized how GE would leverage in-service software to drive service revenue and margin growth. Moving from selling products with services added on, Johnson noted, was fundamentally different from anything GE had sold before: "It's no longer about the product or the service; it's all about the business outcome we are driving for our customer." Johnson added, "This change is not just about sales; it's about product management, marketing, sales, and commercial operations, delivery—it involves the whole life cycle, from invention to fulfillment. And that is the essence of how we're tackling the problem."

Several tools and processes were developed to help the teams work across these changes. The sale now often required deep solution architecture involvement, as Johnson acknowledged, to determine the business capabilities required to deliver the right results. "Solution architecture is a presales function that really digs deep into the discovery process with the customer to determine how they make money. It provides a framework to help the sales team knit together the broad array of capabilities at GE, across hardware, software, and services, to build the right offering for the customer," she added. The team developed a readiness scorecard that covered everything from product management to product marketing to account management and sales enablement, bringing all the pieces into a coherent picture. (See **Exhibit 10** for an explanation.) Johnson said, "It's a very robust scorecard that helps prescribe what a business needs to do to be ready to take these solutions to market."

Deal shapes were also changing. "Instead of a features list with pricing and discount caps," Johnson added, "we're shaping deals from the ground up that are based on the value derived by the customer. It's a completely different set of economics that is very disruptive in the industry." The sales approach was also shifting. Johnson explained, "We now get our frontline ready to tell a story that demonstrates how new business outcomes can be achieved. Then we pull in a new cast of characters, including the solutions architects, to support the story and make it come alive for the customer. From end to end, we are choreographing a completely new sales engagement model." At the same time, GE still sold service contracts. All of these activities ran in parallel. Johnson's team, in concert with the sales organizations of each business, was also customizing training plans.

Considerations in a Potential Deal

There were a number of factors at play as the business units considered how to shape Predictivity deals. In one instance, GE faced a competitive situation that involved a hardware and services offering for a potential customer. The total deal was worth $100 million in revenues for GE over 20 years. GE's analysis of the competitor's hardware offering versus its hardware showed an incremental annualized value of $1.1 million per unit for the customer.

The team worked with the business unit to create a Predictivity solution that included hardware, software, and outcomes-based value sharing that offered to deliver $5.7 million of value per unit annually. The sales teams had to convince the customer that this new, integrated hardware and software offering would deliver on the performance promises. GE's sales team also had to showcase how the customer's risk was reduced because GE's CSA offering provided guaranteed reliability and availability of the units. In this instance, the customer agreed to the $100 million, 20-year deal. GE's internal calculations showed that this would provide a contribution margin of 65%, versus the traditional hardware-only sale of 35%, which would not have met GE's margin threshold in this instance.

GE Renewable Energy's Wind PowerUp and E.ON

Another recent deal illustrated some of the shifts that Predictivity solutions prompted in the sales cycle. GE's Renewable Energy had recently closed a successful offering with E.ON, an international energy provider with one of the largest collections of wind farms in the U.S. One insight from the Renewable Energy team's tenX workshop was that several pieces of technology solved a key customer problem—how to get higher annual energy production (AEP) from existing farms. Jeff Wiener, renewables senior sales leader, said, "Our commercial hypothesis was to see if pragmatic customers will be more eager to buy the individual pieces of technology [software and hardware] if we packaged them into one bundled offering—Wind PowerUp—especially if we went in with a pay-for-performance or, more precisely, a 'pay-for-measured' AEP pricing option." The technology involved meant augmenting the existing turbine's controller with software that adjusted performance dials, including speed, torque, pitch, aerodynamics, and turbine controls, helping to maximize the output of a wind farm.

E.ON was a clear choice, as Wiener explained, "They're a progressive customer with a large GE installed base." Given the existing strong relationship, E.ON told Wiener's team to "be creative and present some options." Wiener's team presented three options—two capital expenditure options (CapEx) and one operational expenditure option (OpEx). The first CapEx option offered a guaranteed AEP per turbine per site for a single payment. Wiener said, "This was more like a traditional deal." The second offered a similar outcome but with only a small down payment upfront to cover GE's installation and minor mobilization cost and a revenue-share arrangement, essentially "pay-for-measured AEP." This option provided an agreed time frame for measurement of the AEP, and a fixed rate per 0.1% of each AEP gain. The third option offered an OpEx deal with a five-year time limit. However, summer 2013 market conditions were quite challenging, and as Wiener noted, "It didn't make sense, as the current electricity merchant price just wasn't rich enough."

As they put the options together, the team engaged initially with E.ON's purchasing and procurement team. Structuring the three options required extensive familiarity with their client's balance sheet, financial strategies, and approach to the market. Patrick Woodson, E.ON North America's CEO, explained, "The whole wind industry has of late suffered with the fact that a number of machines haven't lived up to their full potential." Regulation and consumer uptake were only part of the challenges. Wiener acknowledged, "For this kind of sale, we need much more data to truly understand our customer's business and financial situation, how *they* make money. Our sales team now has to do a whole range of new spreadsheet calculations and modeling before we even start to approach the potential customer."

At the same time, Wiener and his team had to manage the client's technical skepticism about how the proposed increased production would be measured. Woodson explained:

> When you're talking about measuring increased production, it is a far more complex idea than it sounds like on the surface. The methodology you use to measure that increase, the way you test it, the way that single test point is extrapolated across a wind farm—all those things can have a big variance in the ultimate outcome. To put it in perspective: on a 200-megawatt wind farm, a single tenth of what we call the net capacity factor [NCF], which is the factor of the production, is about $1 million. Measuring that can be really difficult.

Wiener and his team managed both E.ON's procurement and accounting officers, while also working very closely with the customer's technologists to manage their concerns about the methodology proposed to measure the AEP. The GE team developed a complete methodology, shared through white papers and piloted on select E.ON turbines. "They were right to be concerned about GE measuring this accurately," he acknowledged. "It was very complicated, more like trigonometry than algebra." As the deal gained traction, Wiener and his team negotiated with E.ON's head of purchasing as well as its head of asset strategy at E.ON headquarters in Germany. As the E.ON team readied to present the option to the firm's board, Wiener recalled, "We were able to help them highlight how this was more like installed base development that can bring on megawatt production quicker, with less risk than new unit development." Woodson echoed this approach:

> As we look at additional capital constraints and other things that are affecting the climate industry, these are relatively small expenditures we're talking about. We're usually talking about things that cost $100 million. We're continuing to search for ways to squeeze every little piece of production that we can out of these machines, so customers like us are a pretty viable line of business for them, and this sort of innovation is a strong area of interest of ours going forward.
>
> They put a solution on the table that allowed us to put relatively little money at risk to get additional value out of our assets already in operation. It was a pretty attractive proposal. That was the big selling point for us. We can take very little risk and potentially get a very big upside. Now, consequently, GE is getting a very big upside for taking that risk alongside us, and will likely make a lot higher margins on their products, which we're okay with.

Building out the Ecosystem

Immelt, Ruh, and Comstock were aware that they could only go so far in developing offerings; the market and its players had to be ready, and readiness varied widely across GE's sectors. Nonetheless, Comstock worried about what role GE should play in bringing certain customers along the path to readiness for the Industrial Internet's benefits and opportunities. Each sector was in a different state of maturity, with different legacy software issues. Immelt added, "We have to face the limitations on the ecosystem. We started from the idea of no unplanned down time and asset optimization, but in the end, the maximum customer value is going to be ecosystem and how open can we be? How open do we want this to be? How far are we willing to go?"

Partnering outside GE

Looking beyond its own boundaries, GE partnered with select players to help further the ecosystem. Joint ventures (JVs) provided the opportunity to let a smaller concern run with a discrete idea, keeping it free of GE's internal pressures. Caradigm, a 50-50 JV formed by GE Healthcare and Microsoft in February 2012, developed software to enable health systems and payers to drive continuous improvements in care. Caradigm's senior leadership was evenly split between Microsoft and GE executives, and the board comprised two members from each company. Taleris, a JV between GE and Accenture that developed software and analytics capabilities to manage an entire airline, had recently signed its first significant deal with customer Etihad Airlines, with several additional promising deals in its pipeline. Taleris illustrated the strength of the JV approach in certain instances. A contract was signed between the partners in June, the joint JV was finalized in December, and by February a prototype of the product and service was ready and piloted with the first customer by April. Ruh acknowledged, "The speed at which we executed on the Taleris joint venture is a great form of validation that reinforces why GE Software was set up in the first place." GE Software's legal counsel, Katherine Butler, commented, "Joint ventures may seem like a surprising option for GE, but they can speed up development and establish an appropriate channel-to-market for jointly developed stand-alone technology or IP."

Along with identifying and commercializing opportunities within its businesses, GE relied on important relationships to support steady growth of the ecosystem, including across the business units and with companies such as Intel for sensor technology, Cisco for network hardware, Accenture for service delivery, and Amazon Web Services for cloud delivery. GE had already successfully partnered with Accenture for the Taleris JV and looked for other, similar opportunities. As one GE Software insider noted, "We can really learn from these partners too." But some were skeptical about partnering with a competitor such as IBM. Ruh noted, "Like any company, one big fear when partnering with a company like that is the competitive risks." Immelt had a different perspective, "We partner with competitors. We know there's going to be tons of things we learn and share or give away. You can say on the outside, 'You are opening up Pandora's box. You're going to lose some of the control you have today.' I think that's part of the debate."

Start-ups also provided opportunities. In January 2013, GE had centralized its health, energy, software, and advanced manufacturing start-up investment activities into a single GE Ventures unit, with a new office in Menlo Park, California. The company planned to invest $150 million a year in ventures "across practice areas, including funds targeted for investment as well as technical and commercial collaborations."[40] Magee oversaw business development and ecosystems, managing alliances, partnerships, licensing, investments, and mergers and acquisitions activities specific to the Industrial Internet initiative. He sought strategic alliances and JVs with the benchmark that they would have the potential to generate $1 billion in revenues over five years. Magee added, "We need partners to get reach." He explained the benefit of keeping these investments somewhat independent of GE: "We do a lot of venture investing aimed at accelerating early research in businesses that we'd suffocate if we brought [them] into GE or in businesses we don't necessarily want to own." In June, GE announced a partnership with Pivotal, an enterprise "platform as a service" provider, with a $105 million investment in the VMWare and EMC spinout.[41]

As part of developing its capability in working with external partners and offering innovative Industrial Internet products and services, GE formalized a relationship with Quirky, the consumer product crowdsourcing platform, in November. The platform democratized the generation and selection of consumer products by enabling its community of over 744,000 members to propose, refine, select, and fund innovative new products. A $30 million investment extended an earlier GE investment and committed Quirky to build 30 connected-home products in the next five years. The investment helped get four products—a desktop widget; a smart egg tray; a smart power strip; and a motion, sound, light, temperature, and humidity sensor—quickly onto the shelves of Home Depot and Best Buy before the holiday season.[42] All of the products were controlled through a Quirky-made smartphone app called Wink. As part of this investment, GE also made available hundreds of its patents related to holographic and fast-focusing lens technologies, thin-barrier coatings for electronic devices, and asset-tracking technology.[43] In the Quirky deal, GE also offered its relationships with suppliers and other support for products as they launched. Quirky's Wink app would link and control additional products, and provide an open platform for others to build on.[44] In March, Quirky and GE unveiled the Aros, an 8,000 BTU smart air conditioner. With Wink, consumers could turn the unit on and off based on location. It also tracked local energy prices in real time to provide information on savings.[45] (**Exhibit 11** provides a more complete list of partnerships.)

GE also explored various crowdsourcing innovation opportunities to help internal R&D efforts as part of the initiative. GE Aviation partnered with Alaska Airlines in November 2012 to present Flight Quest, an open data challenge, making two months' worth of FlightStats flight data available on an open platform.[h] Outsiders were challenged to come up with algorithms that could more accurately predict flight arrival times, with a total of $250,000 awarded to the top-five winners. The winner, a doctor in Switzerland, developed an algorithm that predicted arrival times 40% more accurately than current technology.[46] Immelt recalled, "The industry has always thought if you can save two minutes, you can save an incredible amount of fuel. We got nine minutes improvement! Let's hope this can't be done every minute of every day. But as things get more open, who knows what we'll see." More recently, Local Motors, a Phoenix, Arizona–based company that had crowdsourced vehicle design since 2007, joined GE in a partnership to debut a new manufacturing process.[47]

Competitors in the Industrial Internet Space

If we don't do this, someone else will.

— Jeff Immelt, CEO, General Electric

Traditional competitors in the Industrial Internet space included other large-scale manufacturers, such as Siemens, Philips, Honeywell, and even IBM. (See **Appendix B** for more detail on individual competitors.) The past decade had seen the landscape evolve for the main players. During Immelt's tenure at GE, Siemens' stock had more than doubled (see **Exhibit 12** for comparative performance of stock), and Siemens had a multidecade head start in China, where GE was counting on future growth.[48] Some claimed that Siemens CEO Peter Loescher, a former GE executive, had "intimate knowledge of GE's plans, methods and weaknesses."[49] And all of the players were making similar moves in terms of R&D investment and external acquisitions, particularly in software.

Other players, such as IBM or Google, had far deeper analytics expertise and big data capabilities than GE, with more talent and a longer history in the space. These companies approached the opportunity from the software down rather than worrying about manufacturing and selling machines with software, giving them flexibility and leverage, and making them agnostic at the asset level. IBM already offered a range of products that brought together data across large systems (stadiums, airports, cities, and so on) to help managers make decisions to improve operating efficiencies, increase sustainable practices, and cut costs. Under its Smarter Cities umbrella, launched

[h] See "Flight Quest" at www.gequest.com.

in 2011, IBM targeted energy and water solutions, environmental solutions, and transportation solutions.

IBM's announcement of its $1 billion IBM Watson Group[i] signaled that the sector was continuing to heat up. Watson Group proposed making supercomputer Watson's cloud-delivered capabilities available for more commercial applications. The new unit, which marked a strategic shift toward developing new kinds of software based on machine learning and big data, would focus on R&D and would provide further talent and investments to support the existing ecosystem. The initial emphasis for Watson-based products was on health care, financial services, retail, travel, and telecommunications; IBM had ambitions to make the Watson Group a $1 billion concern by 2018.[50]

Ruh noted, "We don't want to wake up one day and find we've been focusing on the wrong competitor. It would be like Walmart worrying about Target when it's really Amazon they should be closely watching." But most at GE agreed that it would be very difficult for another competitor to come in because, as Ruh added, "GE harbors the domain knowledge of its industrial assets, which is a very difficult commodity to come by." Nevertheless the competitive and industrial landscape was rapidly changing. Google's January 2014 acquisition of Nest, the smart thermostat company, signaled that the Internet of Things was attracting formidable competitors.

Go Faster?

We're trying to sell them something they don't know they need. And they can't see when it works.

— Beth Comstock, Chief Marketing Officer, GE

Certainly, by January 2014, GE was making steady gains on its initiative; for many, those gains were much faster than expected. Commitment across the business units varied and remained an ongoing goal. "The businesses are good when they start to see a trend; they start buying into it," Ruh commented. "And the executives are very good at asking the right questions to drive the right behavior within their organizations. We have to provide the what, why, and how, and then the advocacy for the movement in order to get people thinking differently."

By the end of 2013, Predictivity solution revenues were reported at $800 million and projected to grow to $1.2 billion by the end of 2014.[51] Projects averaged $20 million to $50 million. Customers of the early rollout reported increased revenues, lower fuel and maintenance costs, less CapEx and downtime, and improved enterprise operations. An additional 14 offerings were scheduled for launch in 2014, taking the tally up to more than 40 solutions. Many more businesses were starting to figure out how to integrate the Predictivity solutions in their CSA offerings to help close the $100–million-to-$1-billion outcome-based services deals.

For Little, the challenge remained how fast he and Ruh could move the company in this direction. Ruh reflected on his concerns: "I feel intense pressure to encourage the businesses to embrace the change faster. In any big company you can create a new business model and build out the supporting programs, but if you don't enlist support from all the key stakeholders, then you will remain at ground zero. I worry about what needs to be done to move early adopters faster, and how to keep

[i] In 2011, IBM released Watson, the supercomputer that could understand natural language, analyze large amounts of data, and adapt and learn from new information. Designed as an advanced question answering (QA) system, Watson's technology was applied to health-care businesses through collaborations with industry leaders. IBM extended Watson's real-world applications by developing the Watson Ecosystem, which brought Watson's services to the cloud for use by independent software vendors, content providers, and talent providers.

those who are the latecomers from falling behind any further. When the obvious is apparent, it becomes too little, too late." Johnson voiced her concerns about speed: "We're trying to transform six Fortune 500 companies all at once." She elaborated:

> The fun part is when you find a quick win in one of the businesses, you share it across the major industrials, and they all copy it. GE has a culture where winning is the way, and we share ideas to help drive success. It's a deeply, deeply embedded learning culture. So when you say, "Look, this works," it catches like wildfire. I've been doing business transformation my entire career and I've never worked in an organization with this powerful of a success-driven, learning culture.

Other questions remained. As a company, could GE own this kind of space, given that the technologies in it were so varied? Ruh was convinced: "Without playing in this space, we risk being commoditized. If this is going to really be the future of our services, then we have to establish critical mass and create an ecosystem around it." But others were less certain. GE's installed base and tremendous capabilities in hardware gave everyone confidence; as Immelt said, "We started from a real position of strength. It's hard to replicate what we do across so many sectors. The transition is going to be moving our customers from agreements that address break-fix scenarios, to ones that guarantee outcomes." Immelt continued:

> But we have to face the current limits on the ecosystem. We started from the position of selling no unplanned downtime and asset optimization, but in the end, the maximum customer value is going to be ecosystem and how open can we be? How open do we want to be? How far are we willing to go? From the outside, you might say, "Look, you are opening Pandora's box; you're going to lose some of the control you have today." I think that's part of the debate. There's no way to do this, no way to make this valuable going halfway.

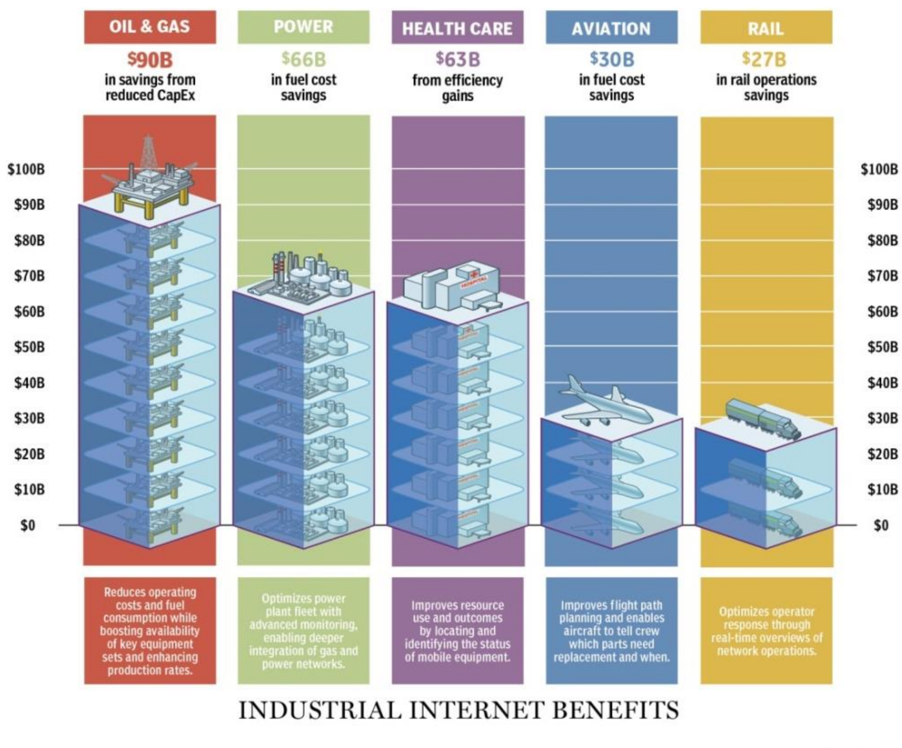
Exhibit 1a Potential Performance Gains in Key Sectors

Industry	Segment	Type of Savings	Estimated Value over 15 Years (billion nominal US$)
Oil & Gas	Exploration & Development	1% Reduction in Capital Expenditures	$90
Power	Gas-fired Generation	1% Fuel Savings	$66
Health Care	Systemwide	1% Reduction in System Inefficiency	$63
Aviation	Commercial	1% Fuel Savings	$30
Rail	Freight	1% Reduction in System Inefficiency	$27

Source: Adapted from company documents; Peter C. Evans and Marco Annunziata, "Industrial Internet: Pushing Boundaries of Minds and Machines," GE Reports, November 26, 2012, http://files.gereports.com/wp-content/uploads/2012/11/ge-industrial-internet-vision-paper.pdf, accessed February 2014.

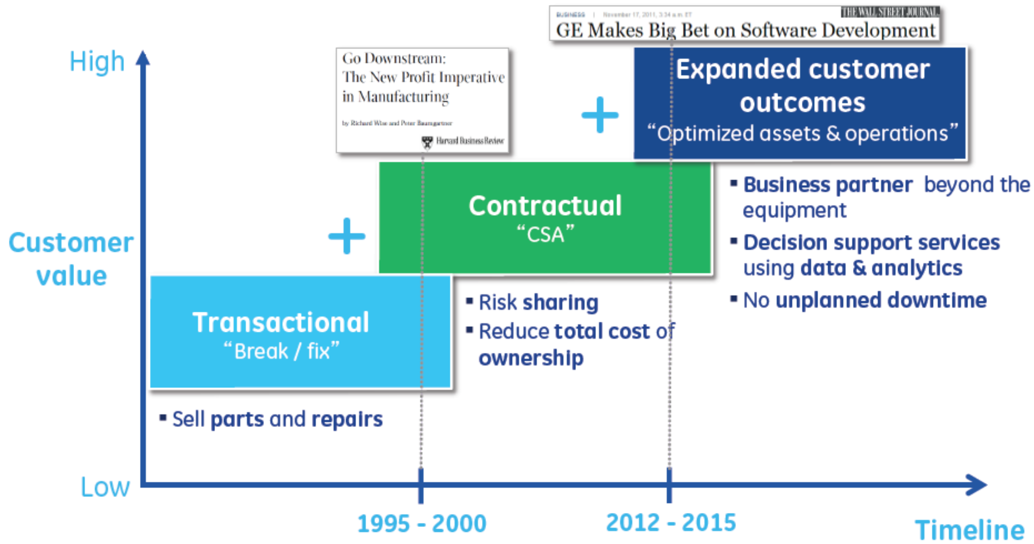
Note: Illustrative examples based on potential 1% savings applied across specific global industry sectors.

Exhibit 1b Projected Benefits of the Industrial Internet: "The Power of 1%"



Source: Company documents; http://www.industrialinternet.com/blog/industrial-internet-a-visual-journey/, accessed January 2014.

Exhibit 2 Evolution of GE Service Models (1980s–2014)



Source: Company documents.

Exhibit 3a GE's Business Units

Power & Water GE's Power & Water segment sold energy production products and services to customers worldwide. Operations were located in North and South America, Europe, Asia, and Africa. Products included gas turbines and generators primarily used in power plants. It also provided integrated gasification combined-cycle technology that converted coal and other hydrocarbons into synthetic gas as the primary fuel for gas turbines. The business sold steam turbines and generators to utility companies, along with wind turbines and solar technology, and water treatment solutions for industrial and municipal water systems. It also offered a portfolio of aftermarket services, including equipment upgrades, long-term maintenance service agreements, repairs, and equipment installation.

Oil & Gas GE's Oil & Gas segment provided equipment for all parts of the industry's value chain. It designed and manufactured surface and subsea drilling and production systems, and equipment for platforms, compressors, turbines, and high-pressure reactors, and offered a portfolio of auxiliary equipment. The Oil & Gas service business maintained 40 service centers and workshops in the main oil and gas extraction and production regions throughout the world. The segment also provided pipeline integrity solutions, sensor-based measurement, and inspection services, along with radiation and measurement solutions. The company owned Wellstream PLC, which expanded its oil and gas portfolio, and the Well Support division of John Wood Group PLC.

Energy Management GE's Energy Management segment designed, manufactured, and serviced technology solutions for the management, conversion, delivery, and optimization of electrical power for companies in energy-intensive industries. It operated in North America, Europe, Asia, Latin America, and the Middle East. The company produced residential, commercial, and industrial applications to manage power such as electrical distribution and control products, lighting and power panels, and switchgear and circuit breakers. Energy Management also provided modernization tools for the grid, including industrial strength communications, smart meters, monitoring and diagnostics, visualization software, and advanced analytics. The business provided plant automation, hardware, software, and embedded computing systems. It owned Lineage Power Holdings, Inc., which provided efficient power conversion infrastructure, and Converteam, which provided electrification and automation equipment and systems.

Aviation GE's Aviation segment produced and serviced jet engines, turboprop, and turbo shaft engines for use in military and commercial aircraft. Its military engines were used in fighters, bombers, tankers, helicopters, and other aircraft. The segment also produced and marketed engines through CFM International, a company jointly owned by GE and Snecma, a subsidiary of SAFRAN of France. The Aviation segment also produced aerospace systems and equipment such as airborne platform computing systems, in addition to various engine components used in commercial and military aircrafts. It also provided long-term maintenance contracts for component repair and overhaul services. Aviation operated in North and South America, Europe, and Asia.

Healthcare GE's Healthcare segment provided health-care technologies to developed and emerging nations. It provided medical imaging, medical diagnostics, patient monitoring systems, disease research, and biopharmaceutical manufacturing technologies. It manufactured, sold, and serviced a range of medical equipment. It also created products used in diagnostic imaging systems and molecular imaging technologies. Health-care technologies included patient and resident monitoring, diagnostic cardiology, ultrasound, anesthesiology therapy, neonatal, and critical care devices. The segment's products were regulated by the U.S. Food and Drug Administration (FDA). It operated in North and South America, Europe, Asia, and Australia.

Transportation GE's Transportation segment manufactured high-powered diesel electric locomotives. It also offered technology solutions to transit, marine, mining, and drilling industries, and owned Industrea Ltd., a provider of mining products and services. Transportation's portfolio of services included repair services, locomotive improvements, and information-based services such as diagnostics and remote monitoring to improve fleet efficiency and reduce operating expenses. The segment had customers in North and South America, Europe, Asia, Africa, and Australia.

Home & Business Solutions GE's Home & Business Solutions sold major home appliances including refrigerators, freezers, electric and gas stoves, dishwashers, washers and dryers, microwaves, and room air conditioners. Brands included GE Monogram, GE Profile, GE, Hotpoint, and GE Cafe. It also provided lighting products for commercial and industrial applications. Its lamp offerings included incandescent, halogen, and fluorescent lights. Home & Business Solutions operated in North America, Europe, Asia, and Latin America.

GE Capital GE Capital offered a range of financial services and products worldwide through commercial loans and leases, fleet management, home loans, credit cards, personal loans, and other services. It provided credit to over 37,000 new commercial customers in 2012 and 34,000 new small businesses throughout the U.S. It operated in North and South America, Europe, Australia, and Asia. Subsegments of GE Capital included Commercial Lending and Leasing (CLL), Consumer, Real Estate, Energy Financial Services, and GE Capital Aviation Services (GECAS).

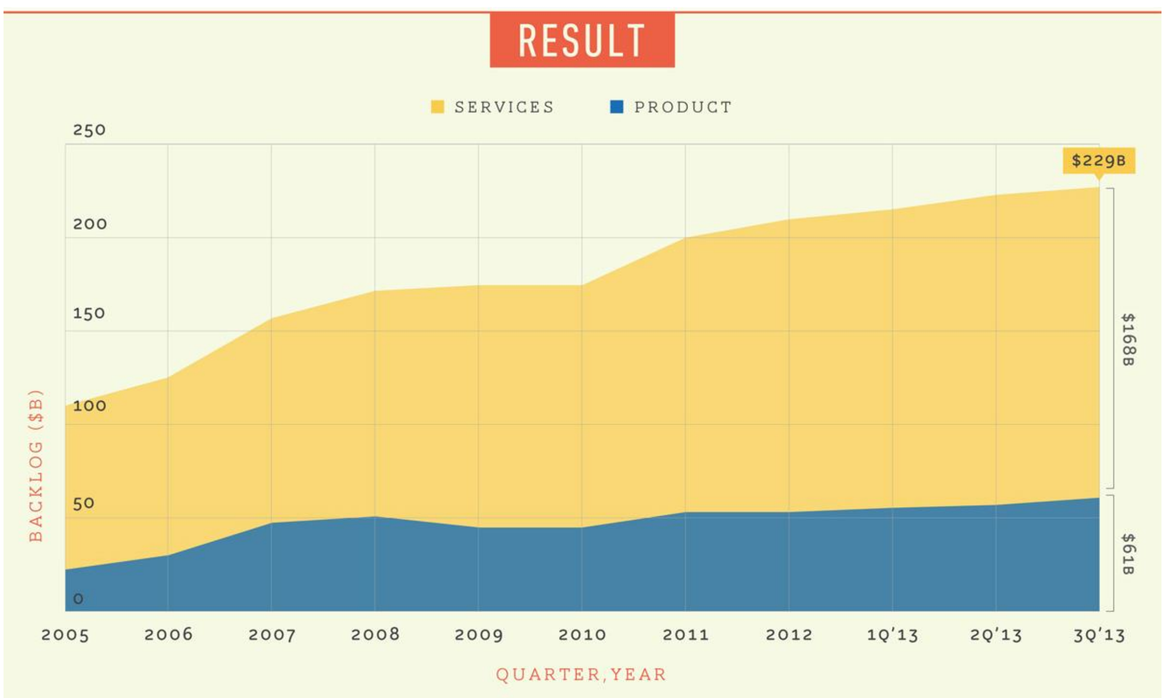
Source: Casewriter research.

Exhibit 3b GE Revenue by Segment, 2008–2012 ($ millions)

	2008		2009		2010		2011		2012	
Segment	**Revenue**	**%**	**Revenue**	**%**	**Revenue**	**%**	**Revenue**	**%**	**Revenue**	**%**
Power & Water	28,537	17.0	27,389	19.5	24,779	18.3	25,675	17.8	28,299	19.0
Oil & Gas	9,886	6.0	9,683	6.9	9,433	7.0	13,608	9.4	15,241	10.0
Energy Management	6,427	3.9	5,223	3.7	5,161	3.8	6,422	4.5	7,412	5.0
Aviation	19,239	12.0	18,728	13.3	17,619	13.0	18,859	13.1	19,994	13.0
Healthcare	17,392	11.0	16,015	11.4	16,897	12.5	18,083	12.5	18,290	12.0
Transportation	5,016	3.1	3,827	2.7	3,370	2.5	4,885	3.4	5,608	3.8
Home & Bus. Solutions	9,304	5.7	7,816	5.6	7,957	5.9	7,693	5.3	7,967	5.4
GE Capital	68,541	42.0	51,776	36.9	49,856	36.9	49,068	34.0	46,039	31.0
Total segment	**164,342**	**100**	**140,457**	**100**	**135,072**	**100**	**144,293**	**100**	**148,850**	**100**

Source: GE Works, 2012 Annual Report, http://www.ge.com/ar2012/pdf/GE_AR12.pdf, accessed February 2014.

Exhibit 4 GE Backlog: Services versus Products (2005–2013)



Source: Adapted from company documents; "Beyond the Break-Fix Model: Predictive Services to Leverage GE's Record $229 Billion Backlog," GE Reports, October 81, 2013, http://www.gereports.com/beyond-the-break-fix-model/, accessed January 2014.

Exhibit 5a GE Rotating Machines and Parts (selected installed base)

Sector	Rotating Machinery	Number of Global Assets	"Big" Things That Spin
Transportation			
Rail: Diesel Electric Engines	Wheel Motors, Engines, Driver, Alternators	120,000	2,160,000
Aircraft: Commercial Engines	Compressors, Turbines, Turbofans	43,000	129,000
Marine: Bulk Carriers	Steam Turbines, Reciprocating Engines, Pumps, Generators	9,400	84,600
Oil and Gas			
Big Energy Processing Plants[1]	Compressors, Turbines, Pumps, Generators, Fans, Blowers, Motors	990	36,900
Midstream Systems[2]	Engines, Turbines, Compressors, Turbo Expanders, Pumps, Blowers	16,300	63,000
Drilling Equipment: Drillships, Land Rings, etc.	Engines, Generators, Electric Motors, Drilling Works, Propulsion Drives	4,100	29,200
Power Plants			
Thermal Turbines: Steam, CCGT, etc.	Turbines, Generators	17,500	74,000
Other Plants: Hydro, Wind, Engines, etc.[3]	Turbines, Generators, Reciprocating Engines	45,000	190,000
Industrial Facilities			
Steel Mills	Blast and Basic Oxygen Furnace Systems, Steam Turbines, Handling Systems	1,600	47,000
Pulp and Paper Mills	Debarkers, Radial Chippers, Steam Turbines, Fourdrinier Machines, Rollers	3,900	176,000
Cement Plants	Rotary Kilns, Conveyors, Drive Motors, Ball Mills	2,000	30,000
Sugar Plants	Cane Handling Systems, Rotary Vacuums, Centrifuges, Cystalizers, Evaporators	650	23,000
Ethanol Plants	Grain Handling Systems, Conveyors, Evaporators, Reboilers, Dryer Fans, Motors	450	16,000
Ammonia and Methanol Plants	Steam Turbines, Reformer and Distillation Systems, Compressors, Blowers	1,300	45,000
Medical Machines			
CT Scanners	Spinning X-Ray Tube Rotors, Spinning Gantries	52,000	104,000
		Total	**3,207,700**

Source: Adapted from company documents; Peter C. Evans and Marco Annunziata, "Industrial Internet: Pushing Boundaries of Minds and Machines," GE Reports, November 26, 2012, http://files.gereports.com/wp-content/uploads/2012/11/ge-industrial-internet-vision-paper.pdf, accessed February 2014.

Note: Not exhaustive.

[1] Includes LNG processing trains, refineries, and ethylene steam crackers. [2] Includes compressor and pumping stations, LNG regasification terminals, large crude carriers, and gas processing plants. [3] Only counting engines in large-scale power generation greater than 30 MW.

Exhibit 5b Scope of the Industrial Internet: GE's Industrial Internet Initiative—No Unplanned Downtime

Industry	Asset Example	Impact of Unplanned Downtime	Benefits of Proactive Maintenance	Profitability Impact
Aviation	Jet Engine	• Safety considerations • Air Turnbacks • Lost revenues from schedule delays and cancellations • Workforce productivity • Maintenance costs for secondary events	• Lower cost, scheduled maintenance • Bottom line revenue impact from fewer cancelled flights • On-time flight schedules • Customer satisfaction • Lower workforce costs	• Per engine—$25K-$100K; per cancellation or diversion—$6K-$8K per delay (i.e., more than 15 min late) • Cost to airline industry for delays and cancellations = $45MM per day globally caused by maintenance related events
Transportation	Locomotive	• Lost revenue for schedule disruptions • Penalties • Network congestion and disruptions • Increased maintenance cost due to failures and secondary damage • Mission failures	• Lower maintenance cost • Improved availability and utilization • Improved network velocity and capacity • Improved customer service	• 400 MM/Year in repair costs from unplanned downtime for a Class 1 RR with a fleet of 2,700 locomotives
Oil and Gas	Drilling Equipment	• Financial impact – lost production • Delivery impact – downstream schedules • Workforce downtime	• Maximum production • Predictable delivery • Lower maintenance costs	• LNG Industry Impact - $882 MM/Year • Mid-sized LNG Plant - $6 MM/Day • Offshore Platform: $23 MM/Week
Mining	Concentrator	• Process variability • Lost production • High maintenance and replacement costs • Unplanned downtime •	• Increased profitability via throughput and recovery improvements • Lower energy and maintenance costs • Increased stability	• Productivity improvement = $8MM annually (per concentrator) * Depending on ore mined • Cost savings = $2MM annually
PetroChemical / Utilities Processing	Heavy Duty Gas Turbine	• Negative revenue Impact due to lost production • Additional maintenance/repair costs	• Extended maintenance intervals increases plant availability • Increased availability increases plant revenue • Alignment of maintenance with all facility assets (integrated maintenance schedule) • Reduced maintenance costs	• $1MM/Day lost revenue for a refinery • For a utility with an average spark spread of $13.15/MWHr and production capacity of 170 MW the lost operating profit opportunity is ~ $45,000/Day
Food Manufacturing	Packaging Line	• Loss of production throughput • Rejected products • Increased Inventory cost • Increased labor cost • Increased maintenance cost	• Increased capacity • Reduced labor cost per unit • Reduce maintenance overtime • Reduced energy cost per unit	• 15% improved overall equipment effectiveness (OEE) • 30% faster new product introductions • 30% reduced inventory • 20% decreased rework
Water & Process Technologies	Cooling Towers, Water Purification, Power Generation Units, etc.	• Cost of repairs for unplanned events = 10 x planned maintenance costs	• Uninterrupted production • Extended production runs • Minimized cost for cleaning and repairs • Avoidance of unplanned capital asset replacement	• Refining example: $800,000 per day in lost profit for a refinery processing 200,000 barrels per day of crude

Source: Company documents.

Exhibit 6 San Ramon, California

Source: Based on data sources on WorldMap, http://worldmap.harvard.edu/maps/sanramon, accessed February 2014.

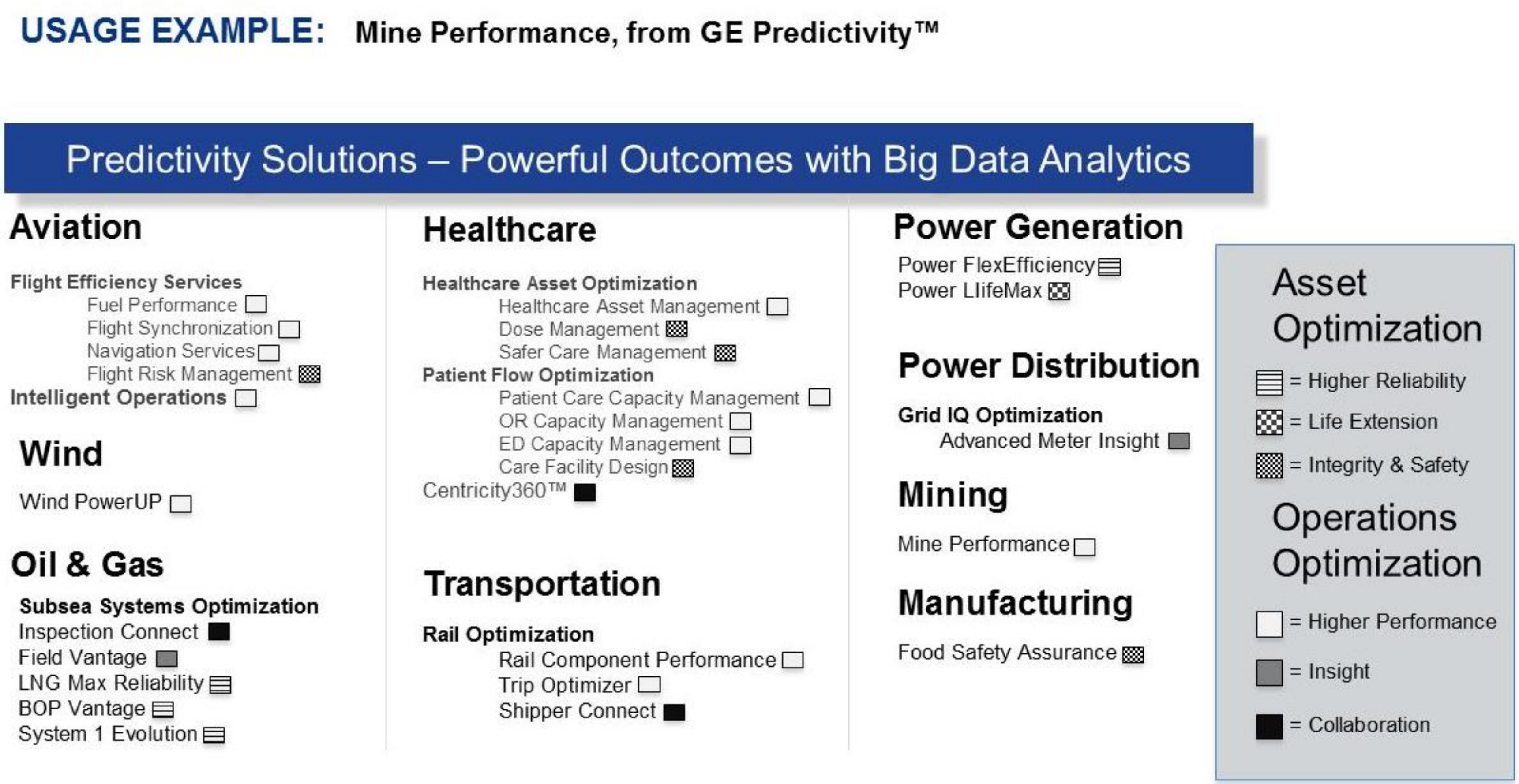
Exhibit 7 Sample tenX Process for Wind Services

Wind Services Proposed Working Sessions

Session	Topics	Loc	Date/Time	Attendees	Milestones
WebEx 1: Kickoff and workplan review	• Team, workplan CE engagement, stairway review • PBS intro (Todd)	webex	July 17 / 1 hr	Wind: Core COE: JM, BS, YH, JL, NS, MS	
WebEx 2: Target customer segment	• Target customer segment (list accounts) • Map Stairway to target segment • Intro to 9pt GTM strategy • Intro to whole offer one pagers (Aviation)	webex	July 31 / 2 hrs	Wind: Core COE: NS, MS	
Workshop 1: Wind Services tenX team session	• Finalize target customer segment—BOE calcs • Bowling alley strategy • Review 9pt GTM strategy (prework + discussion) • Intro to Consumption Economics • Revenue sharing discussion (incl Fin + Pricing) • Whole offer readiness review	SCH	First Week Aug / 1.5 days	Wind: Extended COE: NS, MS, JL (YH), CTO office on phone	
WebEx 3: Wind tenX potential	• Quantify value potential (prework + discussion) • Validation interview questions + targets	webex	August / 2 hrs	Wind: Core COE: NS, MS, JL	
WebEx 4: Validation interviews	• Schedule validation interviews (incl. 3rd party) • Finalize interview guide	webex	August / 2 hrs	Wind: Core COE: NS, MS, JL	
Market Validation interviews	• 45 min interviews with customers	Phone	August/Sept	3rd party	
WebEx 5: Whole offer readiness	• Whole offer readiness roadmap review	webex	Sept / 2 hrs	Wind: Extended COE: NS, MS, JL (YH), CTO office	"SoftBOOST" available Minds & Machines PR
WebEx 6: Market validation interviews	• Market validation interview findings	webex	Oct / 2 hrs	Wind: Core COE: NS, MS, JL (YH)	
WebEx 7: Draft provocation	• PBS training • Build customer provocation	webex	Oct / 2 hrs	Wind: Core COE: NS, MS, JL	
WebEx 8: Provocation tools	• Provocation review • CAR war stories • ROI model inputs • Value scan	webex	Oct / 2 hrs	Wind: Core COE: NS, MS, JL	
WebEx 9: 9point review	• Partners and allies • Sales and channels • Pricing	webex	Nov / 2 hrs	Wind: Core COE: NS, MS, JL	
WebEx 10: Organizing to execute	• Organizing to execute playbook	webex	Nov / 2 hrs	Wind: Core COE NS, MS, JL	Whole offer platform
Workshop 2: PBS training	• PBS training	SR	Dec / 1.5 days	Wind: Extended COE: NS, MS, JL	

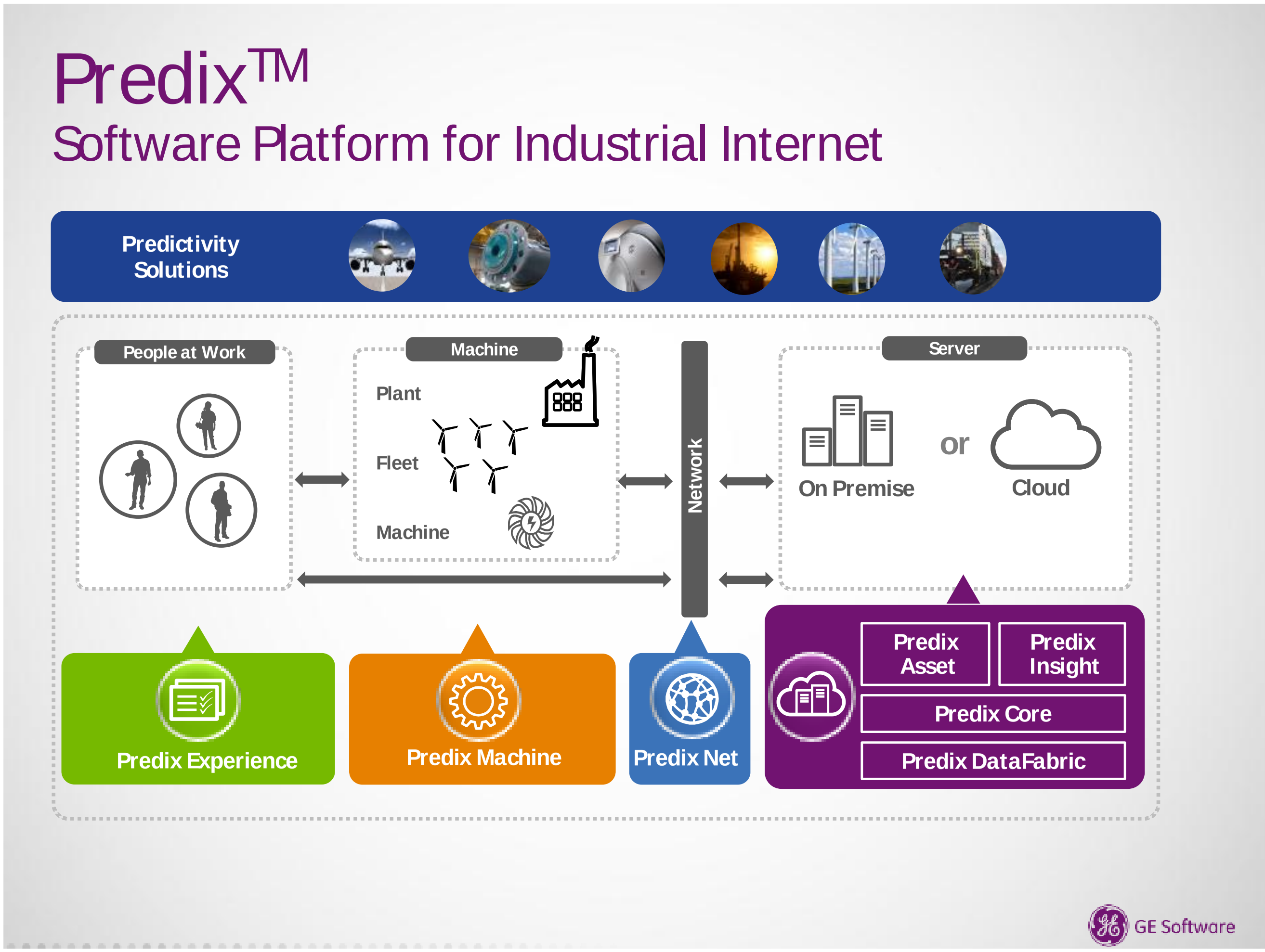
Source: Company documents.

Exhibit 8 GE's Predictivity Solutions (2012, 2013)



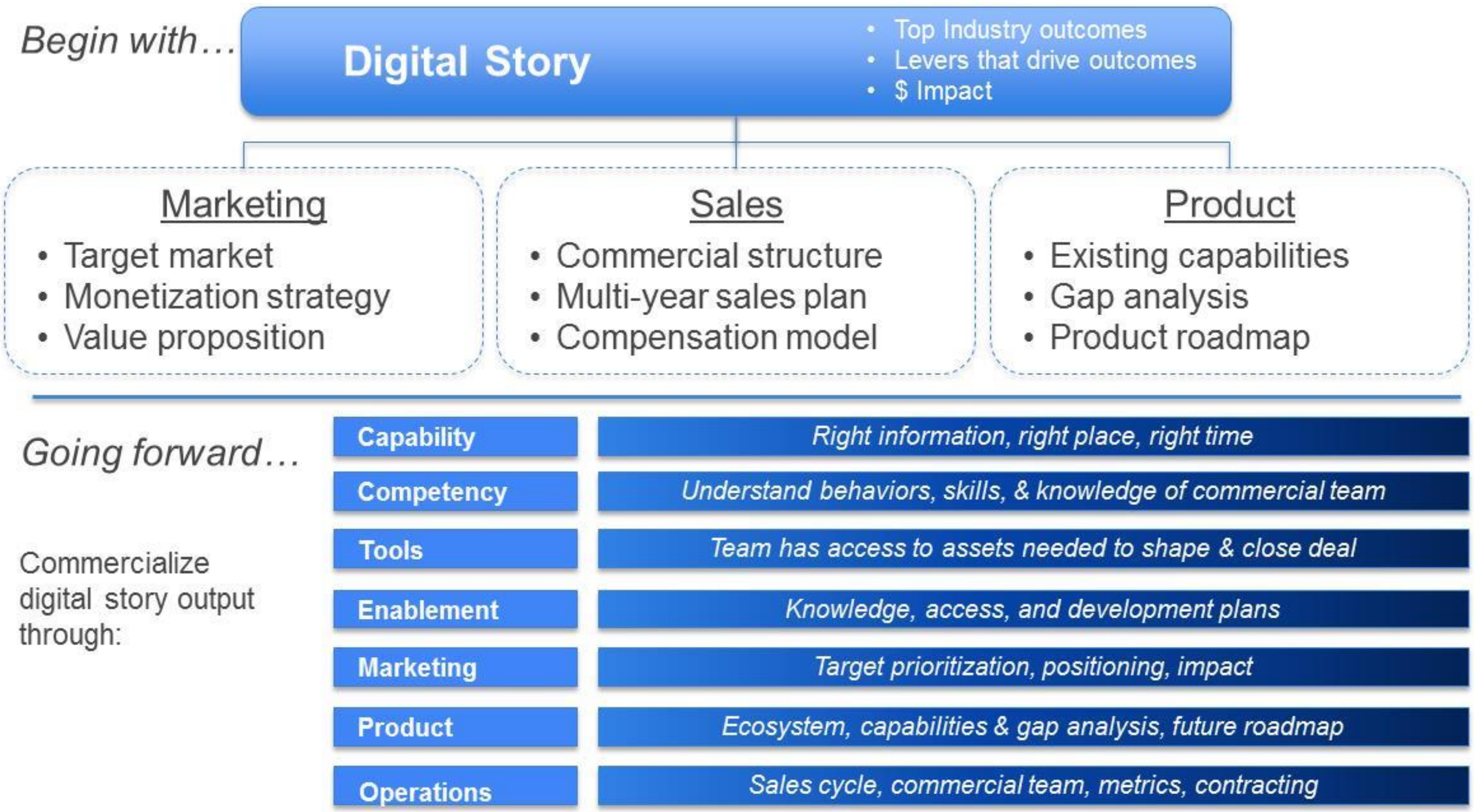
Source: Company documents.

Exhibit 9 GE's Industrial Internet Strategy: Applications and Platform



Source: Company documents.

Exhibit 10 Commercializing the Digital Story



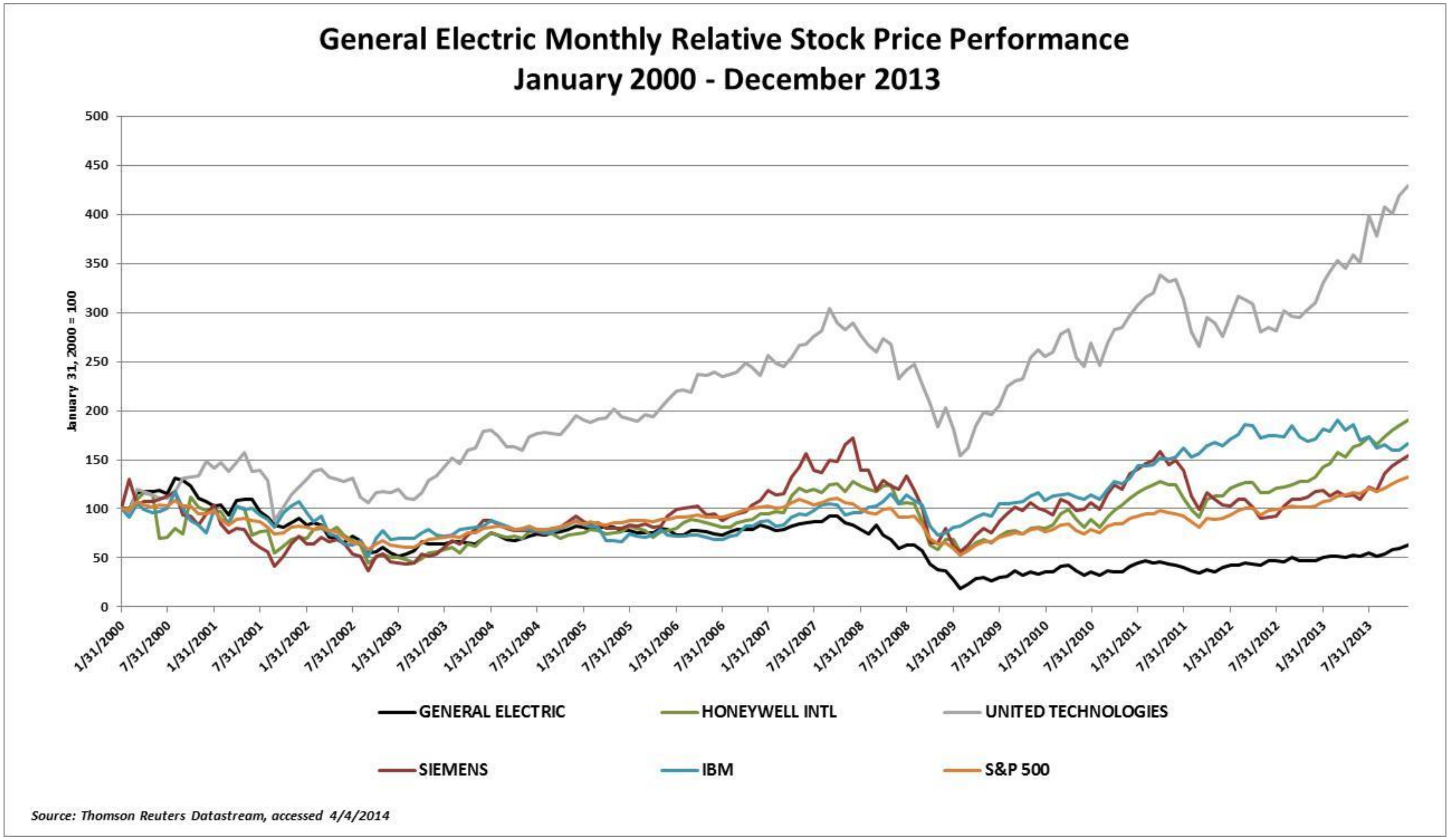
Source: Company documents.

Exhibit 11 Selected GE Industrial Internet Partnerships

Partner	Date	Description
Local Motors	March 2014	GE partnered with Local Motors, a Phoenix, Arizona–based local vehicle manufacturer with three micro-factories. The partnership with GE debuted a new manufacturing process to leverage the power of the crowd.
Mocana	December 2013	Mocana, a device and app security company whose products were used in medical devices, consumer electronics, and industrial automation, received a strategic investment from GE Ventures to expand its product lines, build a global presence, and increase marketing to expedite growth of secure Industrial Internet systems.
PTC	December 2013	GE and PTC, a company that offered technology solutions to help manufacturers achieve sustained product service advantage, accelerated a joint effort to link product design and production execution; GE planned to resell PTC Manufacturing Process Management Software with GE's manufacturing execution system (MES) software.
Yankee Alliance	November 2013	GE Healthcare and Yankee Alliance entered a three-year exclusive purchasing agreement for GE's Hospital Operations Management (HOM) products for use in Yankee Alliance's 164 acute care facilities; HOM replaced multiple operational systems with a single control system to acquire and organize data from multiple sources.
Beijing enCryo Engineering	September 2013	GE acquired a 50% stake in Beijing enCryo Engineering (in connection with its Salof Companies acquisition), originally a joint venture between Beijing Maison Engineering Co. and Salof Companies that specializes in all aspects of oil and gas, chemical, and petrochemical sectors.
AT&T	October 2013	GE partnered with AT&T to develop the cellular and wireless connectivity for its products through AT&T's Wayport division.
XD Electric	August 2013	GE and XD Electric Group, a Chinese company that made electricity transmission and distribution equipment, formed a joint venture to sell equipment and services to upgrade electrical grids.
Pentalum	July 2013	Pentalum Technologies, which created a cost-effective wind light detection and ranging system (LiDAR) for remote wind sensing, received a strategic investment from GE Ventures to support development and growth of its LiDAR systems.
Rosneft	June 2013	GE and Rosneft, a leading oil company based in Russia, signed a strategic agreement to establish a joint venture to develop local expertise and technological solutions for Russia's oil and gas sector.
Amazon	June 2013	GE and Amazon Web Services partnered to develop cloud services to collect and analyze large amounts of data from products and machines.
Pivotal	April 2013	GE invested $105 million for a 10% stake in a venture formed from EMC and VMware to develop applications/operating systems for businesses that could handle large amounts of data.
Montana Precision Products	January 2013	GE Aviation and SeaCast, Inc., a castings and specialty component supplier, formed a 50/50 joint venture to produce jet engine components.
Toshiba	January 2013	GE and Toshiba, which had collaborated on gas turbine systems since 1982, signed a memorandum of understanding to jointly develop combined-cycle power generation projects.
Taleris	November 2012	GE Aviation and Accenture formed Taleris, a joint venture, to provide intelligent operations services that improved efficiency by leveraging aircraft performance data, prognostics, and recovery and planning optimization solutions for airlines and cargo carriers around the world.
Caradigm (Microsoft)	June 2012	GE and Microsoft formed a 50/50 joint venture to develop open health-care intelligence platforms to allow health-care systems and professionals to use real-time data to enhance care quality and patient experience.
Care Innovations	January 2011	Following a health-care alliance started in 2009, GE and Intel formed a joint venture, Care Innovations, to provide technology-based health management solutions for individuals and institutions in areas such as disease management, independent living, and assistive technologies.

Source: Casewriter research; Gabrielle Karol, "Local Motors Bringing Crowdsourced Innovation to GE," Fox Business, March 18, 2014, http://smallbusiness.foxbusiness.com/technology-web/2014/03/18/local-motors-bringing-crowdsourced-innovation-to-ge/, accessed April 2014; "Mocana—Securing the Internet Once Device at a Time," GE Ventures blog, December 2013, http://geventures.tumblr.com/post/69834936798/mocana-securing-the-internet-one-device-at-a-time; "GE and PTC Expand Collaboration with Reseller Agreement, Joint Product Development, Sales and Marketing Activities," ENP Newswire, December 9, 2013, via Factiva; "GE Healthcare; Yankee Alliance and GE Healthcare sign exclusive Hospital Operations Management Agreement," *Investment Weekly News*, November 30, 2013, via Factiva; GE, "GE Closes on the Joint Venture Portion of its Salof Acquisition," press release, September 23, 2013, http://www.genewscenter.com/Press-Releases/GE-Closes-on-the-Joint-Venture-Portion-of-its-Salof-Acquisition-42c0.aspx; Stacey Higginbotham, "GE teams up with AT&T and Intel to conquer the industrial internet. Here's its plan.," Gigaom, October 9, 2013, http://gigaom.com/2013/10/09/ge-teams-up-with-att-and-intel-to-conquer-the-industrial-internet-heres-its-plan/; "GE Completes joint venture with XD Electric," Yahoo Finance, August 27, 2013, http://finance.yahoo.com/news/ge-completes-joint-venture-xd-201422730.html; GE, "GE and Rosneft Announce Joint Venture to Modernize Russia's Oil and Gas Infrastructure," press release, June 21, 2013, http://www.genewscenter.com/Press-Releases/GE-and-Rosneft-Announce-Joint-Venture-to-Modernize-Russia-s-Oil-and-Gas-Infrastructure-4096.aspx; "GE Moves Machines to the Cloud," Business Wire, June 18, 2013, http://www.businesswire.com/news/home/20130618006446/en/GE-Moves-MachinesCloud#.Us3Bu7T8IbU; Pentalum, "Pentalum Technologies receives investment from GE Ventures," press release, July 10, 2013, http://www.pentalum.com/news-in_v2.aspx?num=59; Don Clark, "GE Joins EMC and VMware in Backing Pivotal Venture," *Wall Street Journal*, April 24, 2013, http://blogs.wsj.com/digits/2013/04/24/ge-joins-emc-and-vmware-in-backing-pivotal-venture/; GE Aviation, "GE Aviation Forms Joint Venture with SeaCast Operation for Jet Engine Components," press release, January 3, 2013, http://www.geaviation.com/press/other/other_20130103.html; "GE and Toshiba Sign Memorandum of Understanding to Form Global Strategic Alliance to Establish a Joint Venture in Combined-Cycle Power Projects and Technology," Business Wire, January 24, 2013, http://www.businesswire.com/news/home/20130124005383/en/GE-Toshiba-Sign-Memorandum-Understanding-Form-Global#.U4jGGfn-t8F; Taleris, "GE Aviation and Accenture Form Joint Venture to Provide Intelligent Operations Aircraft Planning and Recovery Solutions for Commercial Aviation," press release, http://www.taleris.com/taleris-press-nov2012.html; GE Healthcare, "It's Time to Transform Healthcare: Caradigm Officially Launches," press release, June 6, 2012, http://newsroom.gehealthcare.com/its-time-to-transform-healthcare-cardigm-officially-launches/; "Company Overview of Intel-GE Care Innovations, LLC," *Bloomberg BusinessWeek*, http://investing.businessweek.com/research/stocks/private/snapshot.asp?privcapId=128188512; and Intel, "'Care Innovations' Unveiled as Name for Sacramento-based Joint Venture," press release, January 3, 2011, http://newsroom.intel.com/community/intel_newsroom/blog/2011/01/03/ge-and-intels-telehealth-and-independent-living-company-is-operational-today; all accessed January 2014.

Exhibit 12 Stock Performance of GE versus Competitors, 2001–2011



Source: Adapted from Thomson Reuters Datastream, accessed April 2014.

Appendix A

The Industrial Internet

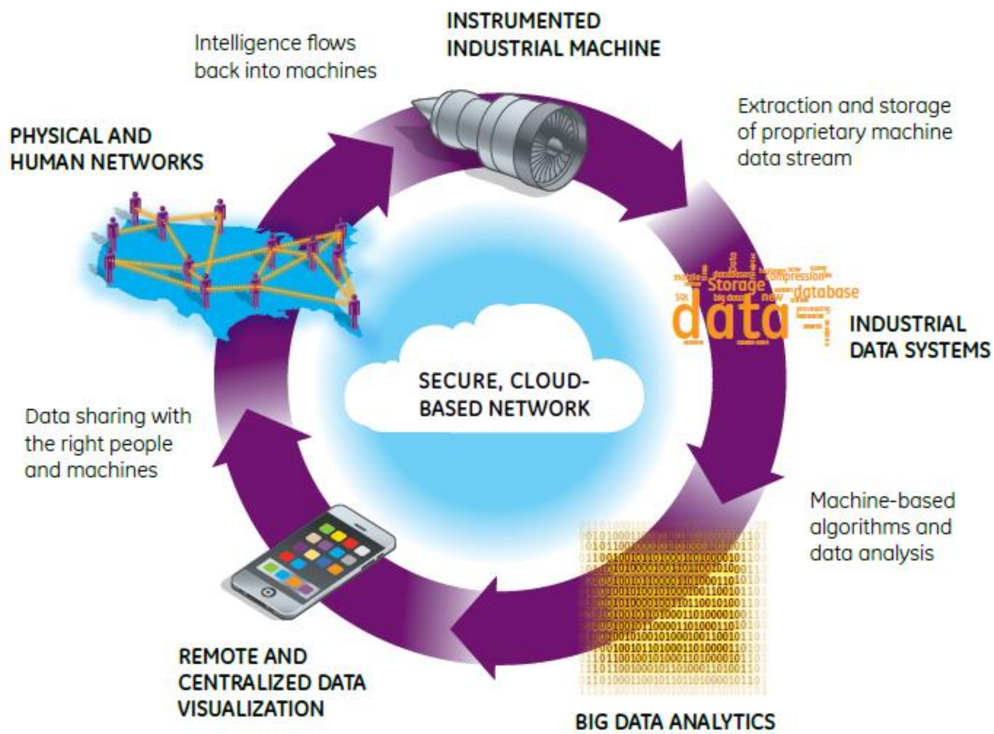
The Industrial Internet data flow began with machine data gathered from devices and networks as they operated. The data was then analyzed, visualized, and stored, either locally or remotely, and helped decision makers make real-time changes or long-term strategic adjustments to individual machines or entire systems. The data could also be shared with the original machine, as well as across multiple devices and networks, allowing the machines to learn from and act on historic data. The local machine could also receive external data to further enhance operation and maintenance processes. (**Figure A-1** provides an illustration.)

The Industrial Internet had the potential to alter a wide range of industries, including aviation, transportation, gas and oil, health care, and energy management: GE analysts expected that 46%, or $32.3 trillion, in global output could benefit from it. In health care, the Industrial Internet could monitor and predict the likelihood of part failure in a device or machine, as well as improve workflow management by understanding patient traffic patterns. Health care accounted for 10% of the global GDP in 2011, and more than 10% of the health expenditures were from inefficiencies in the system. A 1% reduction in health-care costs from the Industrial Internet would yield $4.2 billion in savings per year, or $63 billion over 15 years. The Industrial Internet could also monitor energy systems. For instance, it could detect the wear and tear of wind turbines and prompt preventative maintenance that could extend a turbine lifespan by at least three years. On the energy consumption side, the Industrial Internet could replace manually read monitors to better predict power use and outages and to identify inefficiencies on both city and household levels. The aviation industry could see significant transformations from the Industrial Internet. Data from planes would indicate when parts were expected to fail, so service providers could replace them, thereby reducing downtime, decreasing parts inventory, and increasing customer satisfaction. It could also improve operations by reducing fuel consumption: a 1% improvement in fuel savings in the aviation industry would yield a savings of $30 billion over 15 years. Additionally, the Industrial Internet had the potential to disrupt relationships between suppliers and customers; in the aviation industry, for example, it might allow airlines to pay based on the use of each engine (based on operational data) as opposed to charging per engine. Spending on the Industrial Internet was projected to grow from $20 billion in 2012 to $514 billion in 2020, and the value it created was expected to grow from $23 billion in 2012 to $1,279 billion in 2020.

While the Industrial Internet held great promise, it came with risks and limitations. Unlike the consumer Internet, the Industrial Internet would be used for mission-critical operations, such as maintaining jet engines or delivering proper medication in a hospital setting, and therefore required higher levels of reliability, flexibility, security, and analytic complexity. In order to collect the data, machines had to have sensors from the earliest step in development, which required modifications in manufacturing across many sectors. There was no existing data standard and no common platform on which to base the system. The platforms for storing data would have to be massive and scalable: one wind farm of 500 turbines would create 2 petabytes (10^{15} bytes) of data a year, and one new GE engine used in the Boeing 787 acquired more data in a year than in all of GE's aviation history. Moreover, the storage systems would also have to be extremely secure, given the sensitive nature of the data and the rise in cyber-crime. On the business side, the Industrial Internet would alter the workforce, automating many things that were carried out by hand, but creating demand for new "digital-mechanical engineers," a role that would combine mechanical and industrial engineering.

Finally, businesses would need to overhaul many practices to completely integrate machine data into the decision-making process.

Figure A-1 Industrial Internet Data Loop



Source: Casewriter research; company documents; Christopher Mines and Michele Pelino, "Mapping The Connected World," Forrester Research, Inc., October 31, 2013; Quentin Hardy, "G.E.'s 'Industrial Internet' Goes Big," *New York Times Bits*, October 9, 2013, http://bits.blogs.nytimes.com/2013/10/09/g-e-s-industrial-internet-goes-big/?_r=0; Peter C. Evans and Marco Annunziata, "Industrial Internet: Pushing the Boundaries of Minds and Machines," BGIE Conference Paper, November 26, 2012; Jessica Leber, "General Electric Pitches an Industrial Internet," *MIT Technology Review*, November 28, 2012, http://www.technologyreview.com/news/507831/general-electric-pitches-an-industrial-internet/; David Floyer, "Defining and Sizing the Industrial Internet," Wikibon, http://wikibon.org/wiki/v/Defining_and_Sizing_the_Industrial_Internet; and Jeff Kelly and David Floyer, "The Industrial Internet and Big Data Analytics: Opportunities and Challenges," Wikibon, http://wikibon.org/wiki/v/The_Industrial_Internet_and_Big_Data_Analytics:_Opportunities_and_Challenges, all accessed January 2014.

Appendix B

Selected Competitors

IBM In 2012, International Business Machines, or IBM, had about 467,000 employees and was the fourth-largest company in the world by market value ($241 billion); it reported revenues of $105 billion. As the world's largest IT company, it provided big data, cloud computing, data management, and smart computing services to institutions in the aerospace, banking, communications, electronics, government, health-care, life sciences, and retail sectors, among many others. It was perceived by many as the industry leader in Industrial Internet applications until GE entered the market in 2013.

IBM launched its Smarter Planet initiative in 2008. The program was designed to help "companies understand and analyze the voluminous data streaming off connected devices and industrial equipment and deliver better services to citizens and customers." This program was one of the brighter spots for IBM in a year that saw a 5% decline in its first-quarter revenue as companies' remained hesitant to upgrade IT systems in the ongoing recession.

In 2011, IBM released Watson, the supercomputer that could understand natural language, analyze large amounts of data, and adapt and learn from new information. Originally designed as an advanced question answering (QA) system, Watson's technology was later applied to health-care businesses through collaborations with industry leaders such as Sloan Kettering Cancer Center and Cleveland Clinic. IBM extended Watson's real-world applications by developing the Watson Ecosystem, which brought Watson's services to the cloud for use by independent software vendors, content providers, and talent providers.

In 2013, IBM launched a new series of Power Systems solutions for health care, retail, and "general industry." The firm announced the creation of several new "analytics, cloud, mobile, and social tools" designed to support its PureSystems platform. In April 2013, MessageSight—an appliance directed at consumers who wanted to coordinate and filter the data from their Internet-connected devices—was launched. In October 2013, IBM introduced a joint project with Libelium that offered a relatively inexpensive (between $2,121 and $3,489) "do-it-yourself kit" that customers could customize to gather and analyze inputs ranging from air quality to GPS position, light, motion, or temperature.

In January 2014, IBM announced a $1 billion project to establish the IBM Watson Group, a new business unit responsible for making Watson's cloud-delivered capabilities available for more commercial applications. The new unit, which marked a strategic shift toward developing new kinds of software based on machine learning and big data, would focus on R&D and would provide further talent and investments to support the existing ecosystem. The initial emphasis for Watson-based products was on health care, financial services, retail, travel, and telecommunications.

Table B-1

Year	Revenue (billions US$)	Net Income	Net Profit Margin	Employees
December 2012	$104.5	$16.6	15.9%	466,995
December 2011	$106.9	$15.9	14.8%	433,362
December 2010	$99.9	$14.8	14.9%	426,751

Philips Philips originated in the Netherlands in 1891. By 2013, it was one of the world's largest home health-care corporations and one of the largest producers of lamps and flat-screen TVs, with about 118,000 employees and $32.6 billion in revenues. Philips offered consumers several applications designed to collect data on its lighting and health-care brands. Specifically, its global and marketing director stated that the company would focus on creating citywide smart systems of solid-state lighting (SSL) and light-emitting diodes (LED). Philips also launched a line of household lighting products known as Hue. It allowed consumers to control the shade, tone, color, and brightness of their houses' lighting through a smartphone app. The different kits (including light bulbs and control pad) were first sold in Apple Stores in October 2012. However, the Hue system had very few protective measures and was therefore open to malware attack.

Philips launched several kitchen, bathroom, and bedroom appliances that connected to the Internet. One of these was a toothbrush that downloaded consumers' data directly to their dentists. Other concept products included an air purifier whose settings could be input online, a pressure cooker that downloaded recipes from the web, a baby monitor that operated through cellular networks, and an espresso machine that allowed users to utilize a tablet app to look up and program recipes into the machine.

Table B-2

Year	Revenue (billions US$)	Net Income	Net Profit Margin	Employees
December 2012	$32.8	$0.3	0.9%	118,087
December 2011	$29.3	$1.7	--	125,241
December 2010	$33.9	$1.9	5.7%	119,001

Toshiba Toshiba, founded in 1939, grew from a company that produced household consumer products into one of the largest communications, electronics, IT, infrastructure, and medical equipment conglomerates in the world. In 2013, it had 206,000 employees and reported $63 billion in revenues.

In 2010, Toshiba tasked its new Smart Community Business Division with optimizing infrastructure through smart-grid technology. It marketed these systems to entities seeking to increase the efficiency of biomass power plants, building energy management systems, factory energy management systems, home energy management systems, low-emission thermal power plants, micro-energy management systems, smart meters, storage batteries, solar power plants, transmission and distribution centers, and wind farms.

The company collaborated with Hewlett-Packard in 2011 to create a suite of cloud computing services for institutions operating in the energy, health-care, supply, and transportation sectors. That same year, it acquired Landis+Gyr for $2.3 billion. The Switzerland-based company implemented smart-grid solutions for over 8,000 utility companies around the world. In a press release explaining its purchase, Toshiba stated its intent to become a global leader in the Smart Community business by 2020.

Toshiba purchased a majority stake in cyberGRID, an Austrian energy management company that specialized in efficient generation and distribution in July 2013. This added to its February 2013 acquisition of Consert Inc., another energy management company based in the U.S.

Table B-3

Year	Revenue (billions US$)	Net Income	Net Profit Margin	Employees
March 2013	$63.0	$0.8	1.3%	206,000
March 2012	$75.4	$0.9	1.2%	210,000
March 2011	$78.4	$1.7	2.1%	203,000
March 2010	$69.9	$0.2	--	204,000

Siemens Siemens was founded in 1847 as a German telegraph company and eventually became the largest engineering company in Europe. It operated in 190 countries and focused on electronics and electrical engineering solutions. By 2013, it had 362,000 employees and reported $102 billion in revenues.

In 2007, Siemens bought the software company USG Corp. for $2.5 billion to assist it in developing smart-grid products. Four years later, it acquired Marin Current Turbines (MCT) Ltd. and eMeter. MCT was a U.K.-based marine-energy company; eMeter was a U.S. company that provided software for meter data management functions.

Siemens was a member of the German government's Industrie 4.0 and the REX-COM projects. The former connected individual pieces of factory machinery to operate through the use of "distributed intelligence." The latter used "machine-to-machine communication" technology for resource conservation. Siemens partnered with the European Union on the "Internet of Things at Work" project, which sought to enable factory machines to move seamlessly between productions without commands from their central systems.

As of 2013, Siemens had approximately 17,000 programmers conducting software research and was contracted to collect and analyze data from over 400 energy plants situated around the globe. It also partnered with Allgauer Uberlandwerk GmbH to create a new smart electrical grid. Some of its industrial Internet software products included NX (computation, design, and simulation), Tecnomatix (factory design), Teamcenter (product data), Totally Integrated Automation (factory design), and SIMATIC IT (factory control).

In October 2013, Siemens and Accenture jointly launched the Omnetric Group aimed to help utilities connect their distribution systems, grid operations, and meters in order to create smart grids.

Table B-4

Year	Revenue (billions US$)	Net Income	Net Profit Margin	Employees
September 2013	$102.6	$5.8	5.7%	367,000
September 2012	$100.6	$5.7	5.7%	370,000
September 2011	$100.9	$8.4	8.4%	360,000
September 2010	$103.4	$5.3	5.1%	405,000

Google The Internet services giant Google planned to draw on its software capabilities to enter the connected hardware business. In January 2014, Google announced an agreement to acquire Nest Labs, Inc., for $3.2 billion. Nest Labs was a home hardware technology start-up that designed Internet-connected products such as thermostats and smoke detectors. Nest's products could be controlled over the web and learned from and adjusted to users' behavioral patterns. Nest's interconnected infrastructure would allow Google to move beyond the human-based web into the Internet of Things.

Source: Casewriter research; company websites and annual reports; "Top Companies: Biggest," *CNN Money*, http://money.cnn.com/magazines/fortune/fortune500/2012/performers/companies/biggest/index.html; Jeff Kelly, "With Pivotal investment, GE Takes on IBM to Win the Industrial Internet," Wikibon blog, April 25, 2013, http://wikibon.org/blog/with-pivotal-investment-ge-takes-on-ibm-to-win-the-industrial-internet/; "Motley Fool: IBM's Long-Term Planning May Bode Well for Investors," *Spokesman-Review*, November 17, 2013, http://www.spokesman.com/stories/2013/nov/17/motley-fool-ibms-long-term-planning-may-bode-well/; Trefis Team, "After Weak Earnings, IBM is Playing Catch Up this Year," *Forbes*, April 19, 2013, http://www.forbes.com/sites/greatspeculations/2013/04/19/after-weak-earnings-ibm-is-playing-catch-up-this-year/; Nick Kolakowski, "Big Data's Next Big Battle: IBM Versus . . . GE?" *Slashdot*, June 11, 2013, http://slashdot.org/topic/bi/big-datas-next-big-battle-ibm-versus-ge/; Ricardo Bilton, "The Internet of Things is Coming, and IBM Wants to be at the Center of It," *Venture Beat*, April 29, 2013, http://venturebeat.com/2013/04/29/internet-of-things-ibm/; Agam Shah, "IBM's Do-It-Yourself Kit Makes Internet of Things Accessible," *PC World*, October 21, 2013, http://www.pcworld.com/article/2056580/ibms-doityourself-kit-makes-internet-of-things-accessible.html; Quentin Hardy, "General Electric Adds to its 'Industrial Internet,'" *New York Times*, July 29, 2013, http://bits.blogs.nytimes.com/2013/06/19/general-electric-adds-to-its-industrial-internet/?_r=0; http://iotevent.eu/led-lighting-will-be-connected-to-the-internet-of-things/; Daniel Cooper, "Phillips Hue: The 'World's Smartest' LED Lightbulb that Saves You Time During Red Alerts," *Engadget*, http://www.engadget.com/2012/10/29/philips-hue/; Richard Chirgwin, "Phillips' Smart Lights Left in the Dark by Dumb Security," *The Register*, August 14, 2013, http://www.theregister.co.uk/2013/08/14/switch_off_your_neighbours_lights_with_an_app/; Patrich Salyer, "Identity: The Connective Tissue of the Internet of Things," *All Things D*, October 22, 2013, http://allthingsd.com/20131022/identity-the-connective-tissue-of-the-internet-of-things/; Stephan Shankland, "Phillips Brings Net Smarts to coffeemaker, cooker, air purifier," CNET, September 6, 2013, http://reviews.cnet.com/8301-35205_7-57601645-10391741/philips-brings-net-smarts-to-coffeemaker-cooker-air-purifier/; "HP and Toshiba Join Forces on Cloud Computing," Gigenet Cloud blog, http://gigenetcloud.com/archives/115-hp-and-toshiba-join-forces-on-cloud-computing/; Agam Shah, "HP, Toshiba Collaborate on Cloud Computing," *PC World*, July 16, 2011, http://www.pcworld.com/article/230410/article.html; "Toshiba Acquires cyberGRID," *M2M Magazine*, July 3, 2013, http://www.machinetomachinemagazine.com/2013/07/03/toshiba-acquires-cybergrid/; Simon Thiel, "Siemens Names Merck & Co.'s Peter Loescher New Chief (Update 4), *Bloomberg*, May 20, 2013, http://www.bloomberg.com/apps/news?pid=newsarchive&sid=agxq4nZkE.lc&refer=germany; Trefis Team, "GE Goes to California to Surf Industrial Internet," *Forbes*, November 30, 2011, http://www.forbes.com/sites/greatspeculations/2011/11/30/ge-goes-to-california-to-surf-industrial-internet/; "Will the 'Internet of Things' be Ruled by Giants?" Greenbang blog, December 5, 2011, http://www.greenbang.com/will-the-internet-of-things-be-ruled-by-giants_20813.html; Christian Buck, "The Next Network," February 11, 2013, http://phys.org/news/2013-02-network.html; Jessica Shankleman, "Siemens and Accenture Plug into Smart Grid Market with New Firm," GreenBiz blog, October 17, 2013, http://www.greenbiz.com/blog/2013/10/17/siemens-and-accenture-plug-smart-grid-market, all accessed December 2013; and Geoff Colvin, "Grading Jeff Immelt," *Fortune,* February 11, 2011, http://management.fortune.cnn.com/2011/02/10/grading-jeff-immelt/, accessed January 2014; Marcus Wohlsen, "What Google Really Gets Out of Buying Nest for $3.2 Billion," *Wired*, January 2014, http://www.wired.com/business/2014/01/googles-3-billion-nest-buy-finally-make-internet-things-real-us/, accessed February 2014; and Christina Bonnington, "Google Buys nest for $3.2 Billion in Cash," *Wired*, January 13, 2014, http://www.wired.com/business/2014/01/google-nest-buy/, accessed February 2014.

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