A New Reality for Oil & Gas

Complex Market Dynamics Create Urgent Need for Digital Transformation

Robert Moriarty

Kathy O'Connell

Nicolaas Smit

Andy Noronha

Joel Barbier

April 2015

CISCO

Key Insights

- **Price declines of more than 50 percent** since June 2014 have upended the oil and gas (O&G) sector—and dominate the agenda of industry executives. While the industry has seen many downturns before, a confluence of powerful dynamics suggests this one is different. Oil and gas companies must avoid the temptation simply to cut costs until the price slump passes.

- In a recent Cisco survey, oil and gas leaders indicated that they **are focusing on getting more out of what they already have**. Survey respondents named "operational efficiency of existing projects" and "maintenance of assets and infrastructure" as the top two areas of increased investment over the next 24 months.

- To **maximize operational efficiency**, oil and gas companies must address the "data deluge"—much of it increasingly generated by the Internet of Everything (IoE): the networked connection of people, process, data, and things.

- Many view this as a major challenge: a majority of respondents named "data" as the area of IoE they need to improve most to take advantage of connected technologies. However, O&G leaders clearly understand data's potential—they named "**data analytics** for faster, better decision-making" **as the No. 1 driver for IoE investment**.

- IoE also **generates business and operational advantages**. Respondents identified "faster problem resolution" as the No. 1 business benefit of IoE, while "improved production efficiency" was the top-rated operational benefit.

- These advantages are possible only if key business processes are automated. More than half of our O&G survey respondents believe **IoE has the potential to automate** anywhere from 25 percent to nearly 50 percent of manual processes.

- To realize these improvements, however, many O&G **companies must transform the way they do business—particularly in the area of IT-OT[1] convergence** (people, process, and technology). Fifty-nine percent of survey respondents do not believe that their firms' IT and OT strategies are closely aligned.

- By transforming business processes through IoE, oil and gas companies can capture their share of $600 billion of Value at Stake[2] between 2016 and 2025, according to Cisco Consulting Services. For a $50 billion O&G firm, this translates into an **11 percent bottom-line (EBIT) improvement**.

- According to Oxford Economics, IoE adoption by the O&G industry has the potential to **increase global GDP by up to 0.8 percent**—or $816 billion—by 2025.

"I think when we look back in 10 years' time, the industry foundation will be precisely at this moment of history, where energy prices dipped to the unforeseeable levels of $50 oil."

Graham Hill
EVP, Global Business Development & Strategy, KBR

Introduction

With worldwide production outpacing demand, oil prices have fallen precipitously since June 2014.[4] Several key factors—including continued flat or weakening demand, particularly in China; dramatically increased U.S. production (primarily from hydraulic fracturing and horizontal drilling of oil shale); heightened geopolitical risk; the prospect of increased supply from Iran; and diminishing storage space for crude—suggest that the days of $100-a-barrel oil may not return for years, if at all.

In the past, oil and gas (O&G) companies have attempted to address oil-price declines by resorting to traditional cost-cutting measures, including layoffs and capital expense reductions. Many are taking a similar approach this time—a risky proposition in a time of unparalleled uncertainty for the industry. Indeed, the current scenario could pose potentially disastrous consequences for O&G firms that are not prepared to change their current operating models. For example, since October 2014, at least 10 O&G companies have filed for bankruptcy.[5]

Other, forward-looking O&G firms, however, believe today's turbulent market landscape provides an opportunity to gain competitive advantage by harnessing new technologies. These companies are already reaping sizable benefits: In the Eagle Ford region in North America, for example, improved drilling techniques and technologies are now enabling oil rigs to produce 18 times more efficiently than in 2008, and 65 percent more efficiently than in 2013.[6]

In addition, O&G firms now have the opportunity to achieve further efficiencies through digital technologies powered by the Internet of Everything (IoE)—the networked connection of people, process, data, and things.

The current downturn represents an inflection point for the industry. Major technology advances have enabled some O&G firms to maintain or boost production in lower-price scenarios. This reality has the potential to prolong downward pressure on oil prices. As a result, integration of IT-OT technologies and business processes has become an imperative to boost operational efficiencies and ensure survival.

About This Study

To help global O&G firms both survive and thrive in today's challenging market environment, Cisco Consulting Services undertook a comprehensive global study, including:

1. Survey of **50 industry professionals**: C-suite executives, senior VPs, VPs, directors, consultants, and analysts across 14 countries.[3]

2. Interviews with **Graham Hill**, Executive VP, Global Business Development & Strategy, KBR, Inc.; **Chris Niven**, Research Director, IDC Energy Insights; and **Kathy Bostjancic**, Director, U.S. Macro Investor Services, Oxford Economics.

3. Economic modeling of the **costs and benefits** of applying IoE-enabled technology, based on insights from Cisco Consulting Services' engagements with a range of oil and gas companies. Also includes **macroeconomic analysis** from Oxford Economics.

> "I call it a crisis because it is very disruptive, and the speed of the disruption is really what's causing the problem."

Graham Hill
EVP, Global Business Development & Strategy, KBR

Crude Crash Challenges Survival and Presents Opportunities

The steep drop in oil prices has triggered predictable responses from oil and gas firms. Daily headlines announce capital expense cuts including declines in oil rigs, layoffs, project cancellations, bankruptcies, and mergers—fueled by uncertainty about when (or if) prices will rebound, and by how much.

It is not surprising, therefore, that 86 percent of survey respondents named "energy price volatility" as the most worrying external market force—or that 78 percent also view it as the top inhibitor of growth for their firms.

O&G companies now must make a critical decision: Will they attempt to ride out the downturn by simply cutting costs, or will they use today's challenging environment as the impetus for applying digital technologies to drive innovation while boosting business and operational efficiency of existing investments?

Over the past few years, improved drilling techniques and technologies have significantly benefited both efficiency and production—particularly when it comes to U.S. oil shale. For example:

- Overall U.S. oil production has increased despite cutbacks on the number of operational oil rigs. In September 2011, 1057 rigs were producing 5.1 million barrels of oil per day. In March 2015, 922 rigs were generating 9.4 million barrels per day.[7]
- As little as five years ago, it could take up to nine months to produce oil from a well. Now, firms can see results in 30 days or less.[8]
- Exxon says it has cut the time required to drill a well in the Bakken formation of North Dakota by one-third over the past four years. It has also achieved a 50 percent reduction in the cost of fracturing rock and preparing wells for production.[9]
- ConocoPhillips, one of the world's largest shale-oil producers, can now turn a profit on its U.S. and Canadian wells with prices of $50 a barrel or less.[10]

The industry has a unique opportunity to combine these drilling-technology advances with digital, IoE-driven technologies to deliver new levels of business and operational efficiency. By becoming "digital technology companies," O&G firms can, for example, further improve rig uptime and oil recovery rates, reduce oil spillage, boost employee productivity, and shrink costs.

There is still plenty of room for the industry to become more efficient in all areas of the value chain. For example, experts estimate that shale drillers pull up just 5 percent to 8 percent of the oil in place.[11] Well production is just one area that stands to benefit from digital technologies.

According to Gartner, "the current low-price scenario is unlike prior ones because digital technologies are enabling optimization of business performance, which is increasing the ability of firms to compete at lower price levels. In this downturn,

the ability of an upstream company to continue making strategic investments that improve its ability to compete may be an essential survival skill."[12]

Mark A. Hill of Oilprice.com may have said it best in his March 9, 2015 article entitled "Oil Price Crash a Blessing in Disguise for U.S. Shale"[13]:

"In the past, a downward move of 50 percent would have spelled disaster for the oil and gas industry. This time, a convergence of new factors suggests a different view of what's happening …. In 2015, oil field, drilling, and information technology have combined to create a perfect storm of capability and agility that will allow … oil markets to respond with a speed typically only seen in the digital realm …. In many ways, Moore's Law has finally arrived in the oil patch."

The message is clear: O&G companies must avoid the temptation just to cut costs in hopes of surviving today's price crunch. Instead, they must view the current scenario as an opportunity to make technological and business process innovations that will drive competitive advantage now—and in the future.

Where should those improvements be made? Cisco's survey respondents named "operational efficiency of existing projects or reserves" and "maintenance of assets and infrastructure" as their top two areas of increased investment over the next 24 months. Conversely, respondents indicated that "new capital projects/new reserves," "exploration," and "global presence" (e.g., geographic footprint, remote sites) would be the prime targets of reduced investment over the same timeframe. [Figure 1]

As we will see later in this paper, while digital technologies can benefit all elements of the oil and gas value chain, the largest "upside" for operational improvements resides in the "upstream" part of the business—particularly in the area of production.

> "Operational efficiency and brownfield investment is the number one priority because that's where you get the best incremental return in a down cycle."
>
> **Graham Hill**
> EVP, Global Business Development & Strategy, KBR

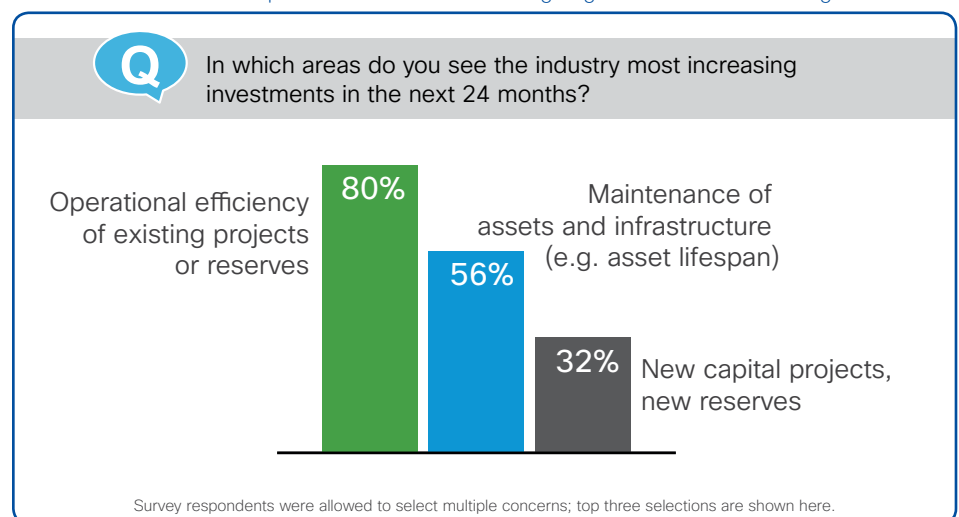## IoE Drives Digital Transformation—with a Focus on Data, People, and Process

As an industry, oil and gas has been "digitized" for some time—perhaps longer than any other sector.[14] What is different now? For the first time, oil and gas firms have the opportunity to make IT services a commodity in the business, creating the potential for dramatic cost reduction and improved efficiencies.

This digital transformation, however, requires adoption of the Internet of

Figure 1
Low oil prices have O&G firms striving to get more out their existing investments.

Q In which areas do you see the industry most increasing investments in the next 24 months?

Operational efficiency of existing projects or reserves — 80%

Maintenance of assets and infrastructure (e.g. asset lifespan) — 56%

New capital projects, new reserves — 32%

Survey respondents were allowed to select multiple concerns; top three selections are shown here.

Source: Cisco Consulting Services, 2015

Everything (IoE)—the networked connection of people, process, data, and things—throughout the O&G value chain, including both the IT and OT elements of the business.

Most O&G firms already have extensive experience with the "things" component of IoE, given the large number of sensors and other devices already deployed throughout their operations. Now, O&G firms need to focus on the other three areas of IoE—data, people, and process—to maximize business and operational benefits—and position themselves for growth.
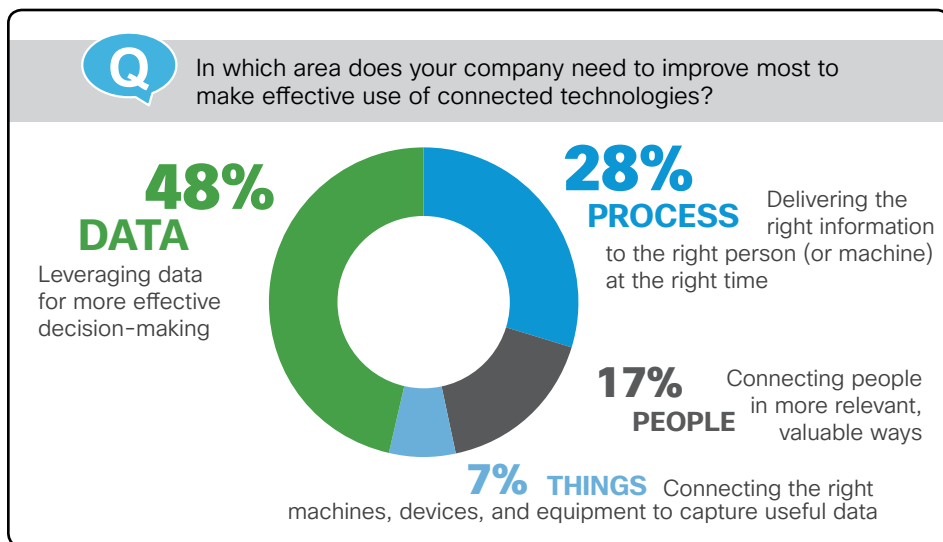
Let's start with data.

Data: Move from Connecting Things to Capturing Insights

Like their counterparts in other industries, oil and gas companies are deluged with all kinds of data—much of it generated by a multitude of sensors and machines spread throughout their far-flung value chain. Despite significant investments in operational technology, however, many O&G companies especially struggle to use real-time operating data to improve functional and business capabilities.[15]

Cisco's survey findings bear this out: 48 percent of respondents named "data" as the area of IoE they need to improve most to make the most effective use of connected technologies (IoE). "Process" ranked second (28 percent), followed by "people" (17 percent) and "things" (7 percent).[16] [Figure 2]

Cisco's survey respondents shared the following comments about the importance of data—and about their firms' current shortcomings in being able to turn that data into actionable insights:

Figure 2
Survey respondents identified "data" as the area of IoE they need to improve most to drive insights and value.

Q: In which area does your company need to improve most to make effective use of connected technologies?

48% DATA Leveraging data for more effective decision-making

28% PROCESS Delivering the right information to the right person (or machine) at the right time

17% PEOPLE Connecting people in more relevant, valuable ways

7% THINGS Connecting the right machines, devices, and equipment to capture useful data

Source: Cisco Consulting Services, 2015

"We don't have enough capture and analysis of information to drive improvement of physical and administrative processes."
  Director, Plant Operations, France

"Data is key, and if the data are not properly acquired and stored, then growth of the business will be negatively impacted."
    Executive, Exploration, Nigeria

"We have data, but it is poorly integrated and poorly analyzed. This makes it difficult for managers to wade through and find the information they really need."
    Executive, Major Capital Projects, Canada

"More data means more efficiency. Better data means more opportunity for analysis. On major projects, it is worth a few percent [improvement] if the analysis and setup are good."

Vice President, Major Capital Projects, UAE

These findings align with those of a 2013 Accenture study,[17] which identified "data integration" as the greatest challenge for oil and gas companies relating to data quality and the ability to analyze data. In that study, more than half of energy respondents cited the format, completeness, and accessibility of data in their firms as problematic. In addition, only 40 percent felt that their data was relevant to the business.

To capitalize on the wide range of data IoE generates, O&G firms must overcome three key challenges (as cited in the Cisco white paper "Attaining IoT Value: How To Move from Connecting Things to Capturing Insights"[18]):

· Integrating data from multiple sources

· Automating the collection of data

· Analyzing data to effectively identify actionable insights

Integrating data. Clearly, integrating data from multiple IoE sources—particularly when those sources are varied in nature and highly distributed—poses significant challenges. Because copying all data to one centralized node for integration is no longer feasible for a variety of reasons—cost, technical difficulty, and possible regulatory issues—organizations are now starting to rely upon data virtualization to integrate widely dispersed data. Data virtualization makes a heterogeneous set of data sources look like one logical database to users and applications. These data sources do not have to be stored locally—they can be anywhere. This is particularly valuable for an IoE application that relies on data from many distributed sources, such as embedded sensors, video cameras, and third-party data sources. [Figure 3]
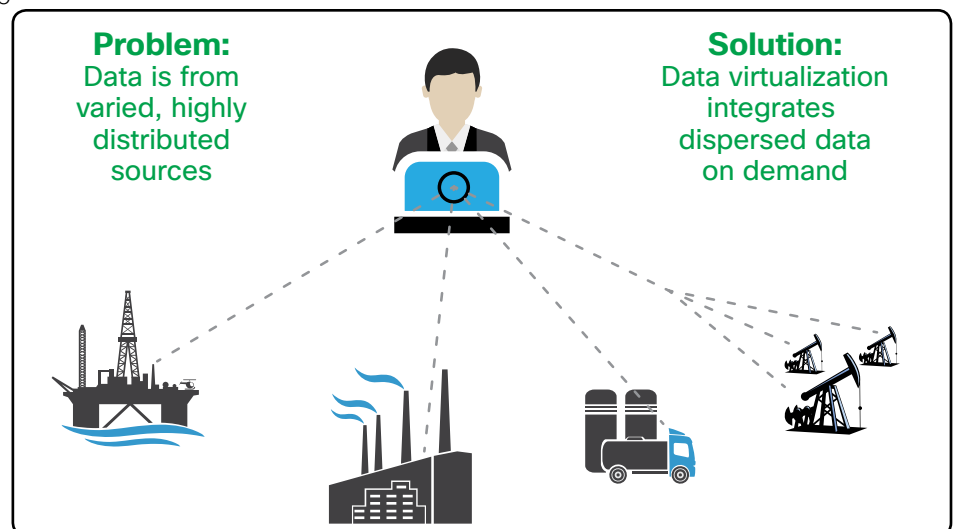
Data virtualization provides another powerful advantage: Because it is designed and optimized to integrate data live, there is no need to physically store all the integrated data centrally. It is only when data from several different sources is requested by users that it is integrated. In other words, data virtualization supports integration on demand. Data virtualization provides instant access to all the data users want, the way they want it. Users can

"The biggest problem is the lack of bandwidth and that it is so expensive. That's incredibly important. And you've got real-time data that is coming from SCADA [supervisory control and data acquisition] about production that you want to tap into. If you are able to process data and turn it into information and knowledge on-site, that alleviates having to use the bandwidth."

Chris Niven
Research Director, IDC Energy Insights

Figure 3
Data virtualization takes distributed sets of data and treats them as one logical database.

Problem:
Data is from varied, highly distributed sources

Solution:
Data virtualization integrates dispersed data on demand

> "If the going gets tough in the industry and you are looking to make cost savings, you will want remote monitoring and remote operation, which is going to require an awful lot of information traffic—intelligent, real-time diagnostics, and then intervention."

Graham Hill
EVP, Global Business Development & Strategy, KBR

retrieve and manipulate data without needing to know how the data is formatted, or where it is physically located.

Traditionally, the process of gathering and integrating data across different parts of the O&G value chain has involved considerable manual effort. Data virtualization helps firms gain a single view of a well and all of its subcomponents, allowing for quicker identification of targets for improved efficiencies—leading to increased profitability.

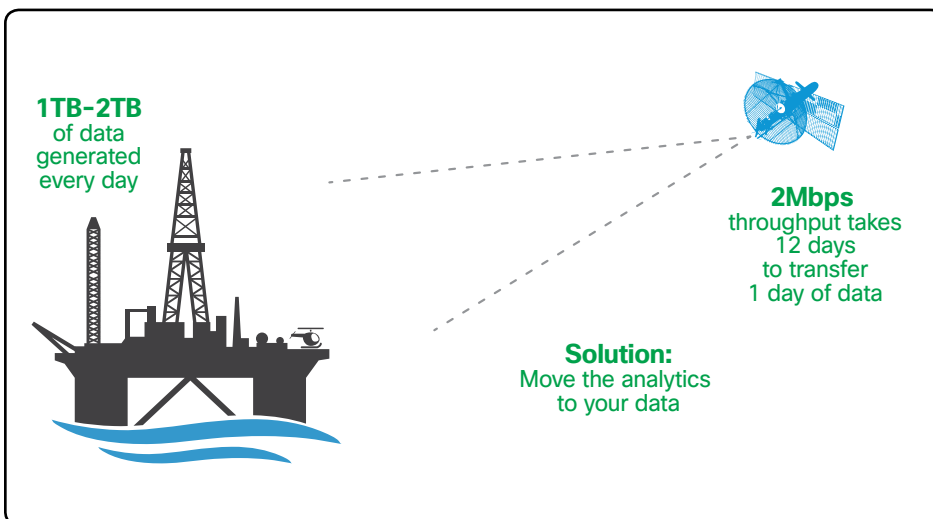**Automating data collection—with the ability to process data "at the edge."**
After IoE data is captured and integrated, organizations face the challenge of getting the data to the right place at the right time so it can be analyzed. This includes assessing the data to determine whether it needs to be moved to the cloud/data center, or analyzed where it is, at the "edge" of the network ("moving the analytics to the data"). Organizations, therefore, require a connected infrastructure that enables insight from the data center to the edge.

"Edge computing" is enabled by the extension of cloud computing and services to the edge of the network—a paradigm sometimes referred to as "fog computing." Fog creates a platform that provides compute, storage, and networking services between end devices and cloud computing data centers. It also supports emerging IoE applications that demand real-time/predictable latency (such as industrial automation, transportation, networks of sensors, and actuators). Thanks to its wide geographical distribution, the fog paradigm is well positioned for real-time data analytics.

The oil and gas industry provides a prime example of the need for "edge computing." A typical offshore oil platform generates between 1TB and 2TB of data per day.[19] Most of this data is time-sensitive, pertaining to platform production and drilling-platform safety. The most common communication link for offshore oil platforms is transmitting data via a satellite connection, with data speeds ranging from 64Kbps to 2Mbps. This means it would take more than 12 days to move one day's worth of oil-platform data to a central repository. There are similar examples across several other industries. In fact, 37 percent of respondents to a separate Cisco survey[20] stated that within the next three years, most of their Internet of Things (IoT)[21] data will be processed at the edge of the network on smart devices. [Figure 4]

Figure 4
While "edge computing" has many applications, it is particularly useful in industries that deploy many sensors in remote locations.


1TB–2TB
of data generated every day

2Mbps
throughput takes 12 days to transfer 1 day of data

Solution:
Move the analytics to your data

Analyzing data. Whether it is in the cloud or at the edge, IoE/IoT data must be analyzed to identify actionable insights that can be used to create better outcomes. Without this critical step, data remains just "data." Insights then need to be embedded into efforts such as process reengineering and broader business transformations. Oil and gas organizations sometimes lack analytical capabilities due to an absence of both the skill sets (such as those possessed by data scientists) and tools to deal with the exploding size, speed, variety, and distribution of data. These firms need to attract or develop employees whose knowledge intersects data science, design, and enterprise architecture. To deliver true value, data insights must link to specific business processes and outcomes.

Respondents to Cisco's oil and gas survey clearly understand the potential of data analytics to drive critical business outcomes: they named "data analytics for faster/better decision-making" as their No. 1 driver for investment in connected technologies such as IoE. "Improved operational efficiencies" and "increased productivity" ranked second and third. [Figure 5]
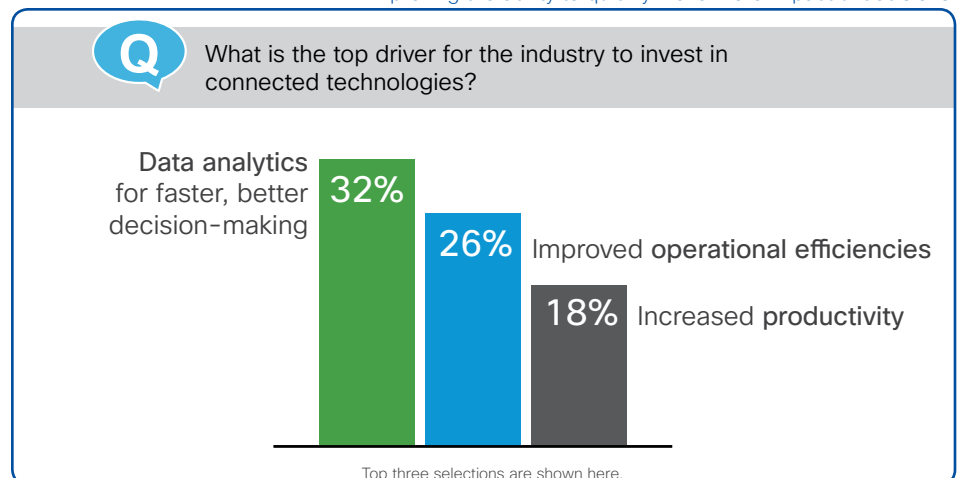
Leaders of O&G firms have growing expectations regarding data analytics' potential to drive tangible business and operational results:

- IDC forecasts that, with a business case built on predictive analytics and optimization in drilling, production, and asset integrity, 50 percent of oil and gas companies will have advanced analytics capabilities in place by 2016. As a result, IDC believes that O&G CEOs, for example, will expect immediate and accurate information about top shale opportunities to be available by the end of 2015, improving asset value by 30 percent.[22]

- According to Gartner, O&G firms' ability to leverage analytics to reduce operating costs and increase production rates "may be an essential survival skill for upstream companies."[23] Gartner mentioned several new analytics methods that are already benefiting the performance of subsurface activities:

  - Digital completion technologies are boosting ultimate recovery rates for unconventional reservoirs from 3-5 percent to 12 or 16 percent, vastly improving those assets' competitiveness.

  - Advanced sensor technologies such as down-hole fiber generate high-resolution reservoir data for conventional assets, enabling more accurate modeling, simulation, and decision-making.

  - Expanded integration of real-time data from field sensors (old and new) with the reservoir model

Analyze Data Closer to the Source

For more insights, please visit
http://cs.co/og-analyze
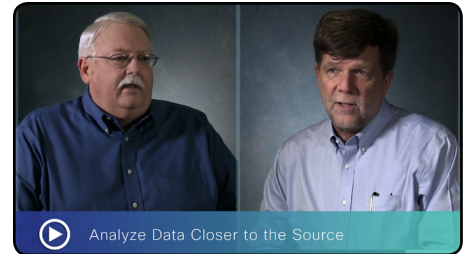
Figure 5
Data analytics can deliver many useful benefits, including improving the ability to quickly make more impactful decisions.

Q What is the top driver for the industry to invest in connected technologies?

Data analytics for faster, better decision-making **32%**

26% Improved **operational efficiencies**

18% Increased **productivity**

Top three selections are shown here.

Source: Cisco Consulting Services, 2015

> "The silo situation is especially profound in the oil industry because as companies grew so rapidly, if they needed a drilling application, they would buy one. If they needed a production application or land, they'd buy it, without much regard for sharing data between those systems."

Chris Niven
Research Director, IDC Energy Insights

is enabling more robust 4D modeling and, in turn, more dynamic reservoir management.

Another example comes from a Canadian oil sands company, which is combining sensors, GPS, and real-time analytics to track the movements of its trucks. Real-time data from the trucks can be viewed on virtually any device, including smartphones and tablets. The solution increases production efficiency, while reducing downtime.

Improved data management and analytics capabilities also have the potential to promote more effective allocation of manpower in oil and gas. When data is preprocessed through effective data management and analytics, for example, the workforce spends more time on capturing insights, rather than having to process the data manually.

Effective data capabilities also enable a more objective view of operations. Rather than relying on institutional knowledge or "gut reaction," oil and gas firms can make better decisions, improve accuracy, and lessen risk. In addition, a common data platform can help break down language/communication barriers between different parts of the business, including IT and OT.

As we will see later in this paper, data analytics and data management capabilities are essential components of the IoE usage examples that drive the most value for the oil and gas industry—in the oilfield, pipeline, and refinery. They play a pivotal role in improvements such as increasing uptime and recovery rates, making better decisions, enhancing refining capacity, reducing lifting costs and cost overruns, and more.

The ability for analytics to generate actionable business insights is largely dependent on the information available for analysis. Too often in the oil and gas industry, however, organizational "silos" deny or limit access to this information—severely curtailing the potential impact of data analytics for many firms. For example, nearly two thirds of respondents to an Accenture survey indicated that their firms continue to manage analytics by specific function or department, preventing an integrated approach for end-to-end workflows throughout the company's operations.[24]

Therefore, in addition to "data," the time has come for oil and gas firms to focus on honing the "people" and "process" elements of their businesses. Their survival could depend on it.

People and Process—Break Down Silos To Achieve End-to-End Visibility

In its recently published "FutureScape: Worldwide Oil and Gas 2015 Predictions" report, IDC predicted that "80 percent of top oil and gas companies will reengineer processes and systems to optimize logistics, hedge risk, and efficiently and safely deliver oil and gas by the end of 2017."[25]

For oil and gas firms to realize the full promise of IoE, they must focus these business process reengineering efforts on eliminating the siloed approach they have traditionally taken regarding digital technology selection and innovation. In many oil and gas companies today, for example, upstream and downstream domains use different solutions for common tasks such as asset performance management. In addition, OT is often managed autonomously from IT, even for critical functions such as reliability and cybersecurity.[26]

These silos increase costs, limit business agility, and cripple IoE's ability to deliver business and operational benefits throughout the O&G value chain. According to Gartner, "with increased competition and lower revenue being generated through lower oil prices, now is an opportunistic time for forward-thinking CIOs to drive digital convergence and thus make their organizations more competitive."[27] Effective IT-OT convergence[28] has many benefits, including optimized business processes, enhanced information for better decisions, reduced costs, lower risks, and shortened project timelines.

Survey Underscores Need for IT-OT Convergence

Cisco's survey respondents had a mixed reaction when asked about the effectiveness of IT-OT convergence in their companies. On the one hand, 59 percent either "completely" or "somewhat" disagreed, or neither agreed nor disagreed, with the following statement: "Our company's IT and industrial control systems (OT) operational strategies are closely aligned." [Figure 6]

This group of respondents provided comments like these:

"We are working in "silos" and have no standardized systems and work processes."
            SVP, Capital Projects, UAE

"Organizations generally suffer from the need to generate more alignment. Right now, people operate multiple programs that don't work alongside each other and processes that do not work when shared between partners …. Technology may be a useful tool to force more common standards, so there is less waste and fewer errors."
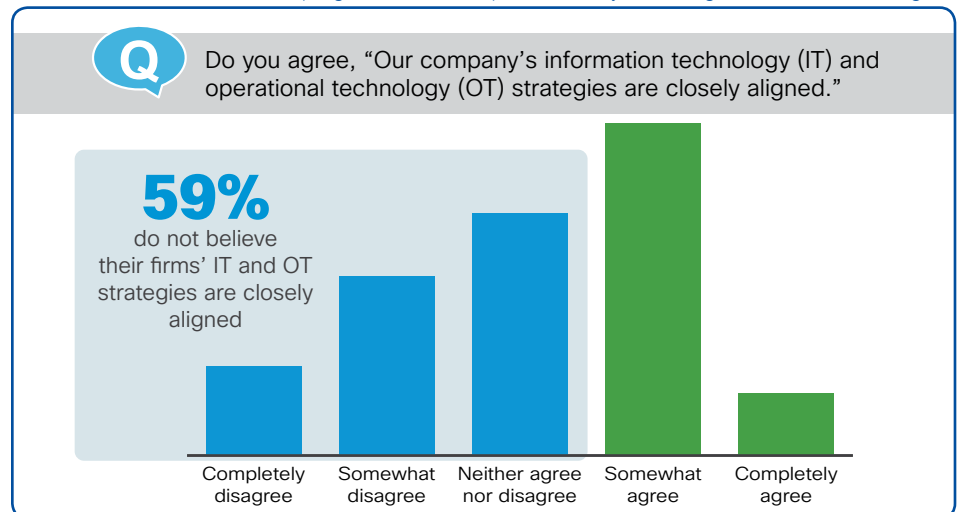 Director, Industry Analyst, Australia

On the other hand, 41 percent of respondents either "completely" or "somewhat" agreed that their firms' IT

Automate to Compete

For more insights, please visit
http://cs.co/og-automate

Figure 6
While some have made progress, most companies have yet to integrate IT and OT strategies.

Q Do you agree, "Our company's information technology (IT) and operational technology (OT) strategies are closely aligned."

59%
do not believe their firms' IT and OT strategies are closely aligned

| Completely disagree | Somewhat disagree | Neither agree nor disagree | Somewhat agree | Completely agree |

Source: Cisco Consulting Services, 2015

> "What a lot of companies are going to need to do is to have a framework in place that allows them to capture data, share data—collaboration is so key to the success of oil companies these days."

Chris Niven
Research Director, IDC Energy Insights

▶ Remove Silos for Accurate Data

For more insights, please visit
http://cs.co/og-silo

and OT strategies are aligned. This may be an indication that their companies have begun to take the steps required to foster a strong IT-OT partnership on the road to becoming digital businesses.

Those steps should begin with a concerted effort to develop or attract employees who can see across IT and OT. These individuals must possess the knowledge, skills, and experience to manage IT software—along with a strong understanding of engineering and operations.[29]

According to research from Aberdeen Group,[30] successful IT-OT convergence also requires an effective organizational structure that will, for example, allow OT to leverage IT's unique skill set to reduce installation and operating costs of industrial control systems. Companies can break down silos and overcome cultural barriers by forming cross-functional teams and by building the expertise to manage network access, availability, and performance. Cross-functional teams also help ensure balance so that new initiatives are not pulled too far in any particular direction.

IT and OT must work toward a common goal, with an executive sponsor to effectively execute their vision. Aberdeen writes: "The opportunity exists now more than ever to overcome the historic isolation of the control platform from the enterprise. Moving forward, it is time … to visualize the real-time enterprise and take steps to lay the real-time network foundation that they need to support it."

In addition to data analytics (as described above), effective IT-OT convergence is essential to optimizing an oil and gas firm's capabilities in two other critical areas: collaboration and security.

IT-OT Convergence Enables Improved Ecosystem Collaboration

Traditionally, siloed operations in oil and gas firms have produced cross-functional interactions that are more transactional than collaborative. These silos impede not only internal collaboration, but also interactions among companies, partners, governments, and research institutes. As a result, field workers from different services companies are unable, for example, to access a common, dynamically updated shift plan. In another case, collaborative silos also can prevent field workers and production operators from being able to dynamically develop an on-the-spot repair plan for a down well needing new parts.[31]

As oil and gas projects grow in size, scope, and complexity, companies must manage greater risks—particularly in the area of potential cost overruns that directly impact the bottom line and workforce. A stronger collaborative ecosystem is critical to manage this risk by making partnering easier among various parties involved in capital projects. To be transformative, collaboration must strengthen the capabilities of a project's people, processes, and technology, all within a reliable, secure environment. A recent IBM survey suggests that oil and gas companies need to make significant improvements when it comes to collaboration; however,

less than 55 percent of respondents rated the effectiveness of their current project collaboration as "good" or "very good."[32]

By combining business process reengineering with IoE-enabled collaboration capabilities, digital oil and gas companies can reap a host of benefits, including the ability to make better and faster decisions, reduce downtime/flat time, improve productivity, and much more. Here is an example of how one oil and gas company is using IoE-driven collaboration today to drive business and operational advantages:

- Saipem, an Italian oilfield services company, was challenged with reducing operational costs, improving time to market, and building staff loyalty. By employing high-definition video conferencing, Saipem has cut travel costs, boosted productivity, and improved its ability to provide subject-matter expertise throughout the company, and with partners. In addition, web conferencing enables easier and more effective communication among sites and with customers; reduces the time required to resolve computer failures from hours to minutes; and makes it easier for employees in remote locations to stay in touch with loved ones.[33]

With 50 percent of oil and gas employees eligible for retirement within the next five to 10 years,[34] video-based collaboration will provide a critical means of bridging the expected talent gap. As demonstrated by the previous example, video collaboration offers a cost-effective solution for extending scarce expertise to remote locations—without the need for travel.

The other side of the coin is ensuring that the proper technologies and processes are in place to attract and train the next generation of workers. According to IDC,

"A young engineer can sit down with the subject-matter experts and go through the process of optimizing an oilfield. And not only does it help when you're actually creating the well itself, but you can store it for collaboration with young engineers, so that when the 53-year-old engineer leaves, that intellectual property doesn't go with him."

Chris Niven
Research Director, IDC Energy Insights

Examples of IoE-Enabled Collaboration in Oil and Gas

U.S. Oilfield Services Company

A U.S. oilfield services company employs advanced drilling techniques that are service-intensive and require specific expertise. Other challenges include availability of experts, along with travel risks and restrictions. Using collaborative technologies such as web conferencing and unified communications, the firm now can provide on-demand expert guidance and faster problem resolution (typically on first pass).

Global Oilfield Services Company

By combining video conferencing, web conferencing, and unified communications, a global oilfield services company has cut travel costs by 25 percent, while also reducing downtime/flat time and enabling better decision-making, remote training, and proactive monitoring of operations.

Westfalen Weser Energy

Westfalen Weser Energy of Germany is using video collaboration to extend remote expertise to field technicians. Among other benefits, the solution has significantly improved the firm's service and repair process.

More: Case Study

"with continued labor shortages and over one-third of the oil and gas workforce under 45 [years of age] in three years, oil and gas companies will turn to IT to meet productivity goals."[35] Collaboration solutions such as video conferencing and web conferencing enable the knowledge sharing and training that will be required to prepare this younger workforce quickly and effectively, with minimal disruption to company operations.

IT-OT Convergence Promotes Stronger Cybersecurity Across Operations

According to Gartner, a growing number of regulatory directives aimed at critical infrastructure security—combined with uncertainty about how they will affect the business of oil and gas—are creating an urgent need for stronger cybersecurity in OT environments.[36] In addition, OT's increasing use of IT infrastructure to replace its own proprietary infrastructure is spurring greater collaboration between IT security staff and OT engineers. This is fueling faster convergence between IT and OT in the area of cybersecurity than in other aspects of the oil and gas business.

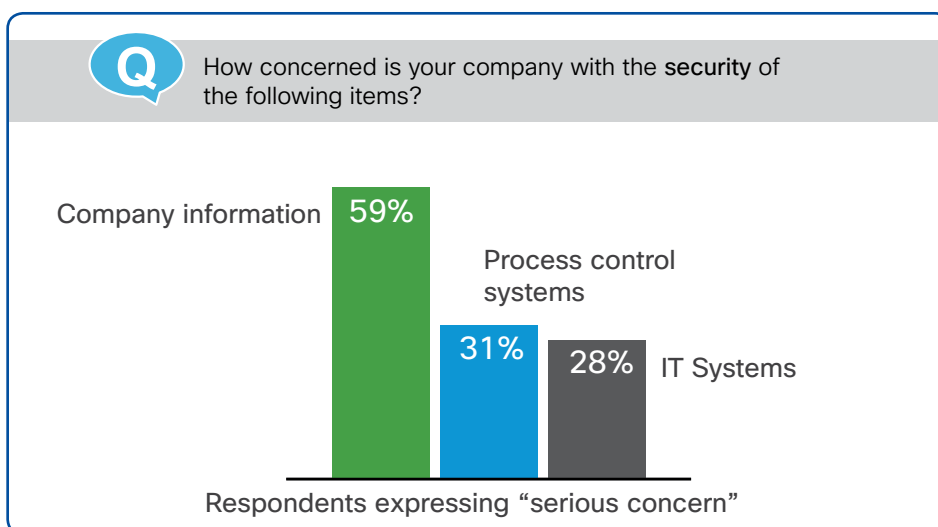This is good news for the oil and gas industry, and comes just in time:

- According to the Department of Homeland Security, 53 percent of all cybersecurity incidents in the six months ending in May 2013 occurred in the energy sector, and the number of attacks is increasing.[37]
- A study by Fox-IT reported that 60 percent of oil and gas companies do not have a cybersecurity incident response plan. In addition, only 11 percent are fully confident that they can address a cybersecurity breach appropriately. Twenty-three percent admitted that they are not actively monitoring their network for potential intrusions.[38]

Oil and gas firms must have the proper cybersecurity measures in place to succeed with IoE—particularly as the mounting number of connected field-based sensors and greater use of closed-loop systems (i.e., systems where machines, not humans, monitor, analyze, decide, and implement changes to the operating environment) introduce new areas of vulnerability.

This environment is creating more opportunities for professional cybercriminals and even hacktivists to exploit. Cybercriminals are well-resourced and take the time to find weak links in network defenses. They then exploit that weakness in a low-profile manner, often remaining

Figure 7
Company information is by far the biggest security concern.

Q: How concerned is your company with the **security** of the following items?

Company information — 59%

Process control systems — 31%

IT Systems — 28%

Respondents expressing "serious concern"

Source: Cisco Consulting Services, 2015

undetected for weeks, months, or even years while targeting customer data, intellectual property, and other information.

Fifty-nine percent of respondents to Cisco's survey named protection of "company information" such as customer and transactional data, along with geological maps, as their top security concern. "Process control systems" was the second-biggest security concern (cited as a "serious concern" by 31 percent of respondents), followed by "IT systems" (28 percent). [Figure 7, previous page]

An effective, end-to-end cybersecurity approach—including alignment between IT and OT—delivers many advantages for O&G firms, including increased business agility and risk awareness, lower cost of operations, and reduced downtime. These translate into tangible economic benefits. (For specific actions that can promote cybersecurity in oil and gas, please see the "How to Get Started" section at the end of this paper.)

The Oil and Gas Industry Is Primed for Digital Transformation

Improve personnel safety and optimize processes with wireless real-time tracking, video analytics, and automated incident response.

Reduce downtime and rework with faster and better decisions using real-time analytics and video collaboration.

Improve process efficiency with truck identification, logistics optimization, and automated loading using pervasive wireless and real-time sensor and video data analytics.

Use analytics at the edge to improve security and environmental protection with predictive intrusion-, leakage-, and deformation-detection.

Increase personnel safety and improve asset integrity with predictive maintenance and faster, better decisions using real-time analytics at the edge and virtual expert support.

Provide pervasive wireless connectivity to support education, knowledge sharing, and personnel welfare.

Decrease drilling time and improve accuracy with intelligence at the edge, virtual experts, and automation.

The Bottom Line: A Potential 11% Annual Profit Increase

When oil and gas companies master the "data, people, and process" elements of their businesses, IoE can deliver measurable impact in the industry's key areas of focus: improved efficiency and cost savings. Respondents to Cisco's survey clearly recognize that potential.

For example, when we asked oil and gas leaders to identify the top business benefits of connected technologies (IoE) for their industry, "faster problem resolution" was their top choice, followed by "better process control" and "improved worker safety."

In terms of IoE-driven operational benefits, "higher production or recovery rate" ranked No. 1, with "reduced equipment downtime" and "reduced CapEx for production/lifting costs" the No. 2- and No. 3-rated benefits.

Survey respondents believe that digital technologies will boost operational efficiencies primarily in the upstream segment of the value chain: they named "production" as the No. 1 beneficiary, followed by "development" (i.e., major capital projects) and "exploration." Similarly, when we asked them to name the one area where IoE could make the biggest impact on their business, "production / production monitoring and control" was the top choice, followed by "data analytics" and "exploration."
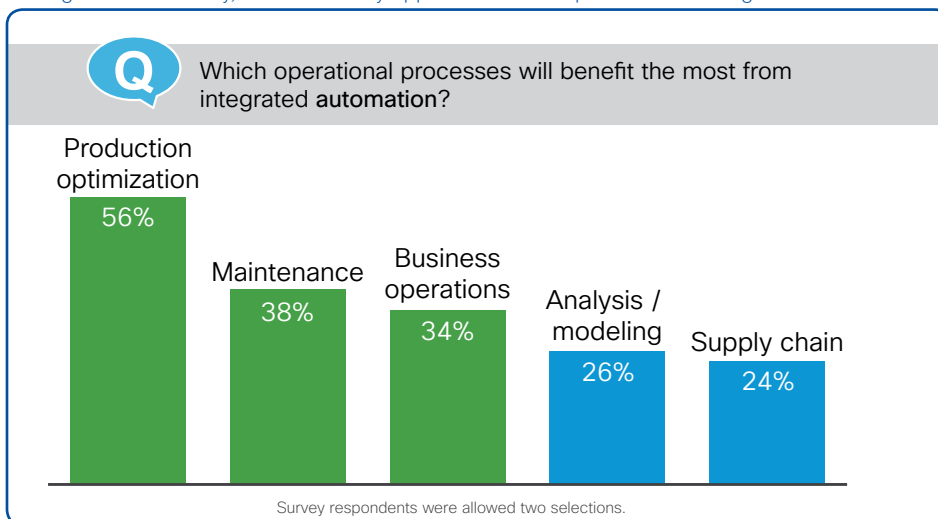
Data analytics-driven insights will create an opportunity for process change and optimization. In many cases, these insights will foster transformative rather than incremental changes in business and operational processes. For example, more than half of our survey respondents believe IoE has the potential to automate anywhere from 25 percent to nearly 50 percent of manual processes. "Production optimization" was identified by 56 percent of respondents as the process that would benefit most from IoE-driven automation, followed by "maintenance" (38 percent) and "business operations" (34 percent). [Figure 8]

The current low-price environment demands that oil and gas companies focus on automating manual processes, which are relatively costly and prone to risks. By removing the "human factor" from certain manual processes, O&G firms can improve efficiency, safety, and accuracy, while reducing risk. With thousands of oil and

Figure 8
Throughout the industry, there are many opportunities for improvements through automation.

Q Which operational processes will benefit the most from integrated automation?

Production optimization 56%
Maintenance 38%
Business operations 34%
Analysis / modeling 26%
Supply chain 24%

Survey respondents were allowed two selections.

Source: Cisco Consulting Services, 2015

gas professionals retiring soon, companies should also be looking to codify many routine analysis and decision-support processes, and to automate them where possible.

What is the potential economic impact of the aforementioned IoE-driven benefits for the oil and gas industry? According to analysis by Cisco Consulting Services, IoE will generate $600 billion in Value at Stake[39] from 2016 to 2025.

To size the potential yearly IoE-driven benefits for a representative oil and gas firm, Cisco Consulting Services performed an economic analysis based on a company with $50 billion in annual revenue, approximately 13,000 employees, annual oil production of about 270 million barrels, and interests in three refineries. The results show that for a company of this size, IoE has the potential to create a $538 million annual profit increase opportunity—equivalent to an 11 percent bottom-line (earnings before interest and tax) improvement. [Figure 9]
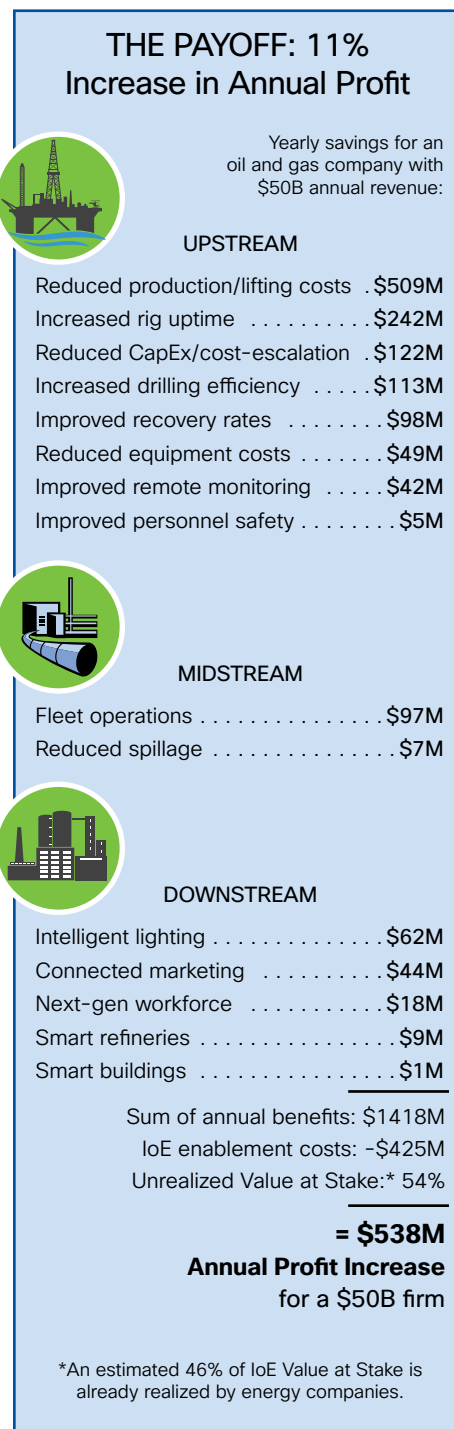
Nearly half of this value (48 percent) comes from enhanced process and supply-chain efficiency—primarily driven by reduced production/lifting costs. Better asset utilization is another key value generator (32 percent), with increased rig uptime delivering most of the value. CapEx savings are the third-highest producer of IoE value (12 percent), largely due to fewer cost escalations on capital expenditures.

Overall, 72 percent of these benefits derive from cost reduction, while the remaining 28 percent result from increased revenues. In addition, while IoE can improve efficiency and cost savings throughout the oil and gas value chain (upstream, midstream, downstream), economic analysis indicates that it has the potential to make the biggest impact in upstream operations. This mirrors the findings of our survey, in which respondents identified production, development, and exploration (all of which are upstream operations) as the three areas positioned to benefit most from IoE adoption in oil and gas.

It is important to underscore the critical role of "data" in driving economic value for the oil and gas industry:

- The largest driver of IoE value for a $50 billion oil and gas firm—reduced production and lifting costs—relies heavily on asset monitoring and data management capabilities to gather more accurate and timely information from wells. Value also comes from the ability to perform automatic analyses, diagnostics, and optimization in real time. Reduced production and lifting costs represent a $509 million annual margin increase opportunity for a $50 billion oil and gas firm.

- The No. 2 IoE value generator—increased rig uptime—depends on advanced sensors, machine-to-machine connections, and Big Data analytics to help anticipate equipment failures and maintenance requirements, thus minimizing downtime. These capabilities create a $242 million annual value opportunity for a $50 billion O&G company.

Figure 9
Digital transformation delivers value across the entire value chain—especially upstream.

THE PAYOFF: 11% Increase in Annual Profit

Yearly savings for an oil and gas company with $50B annual revenue:

UPSTREAM

Reduced production/lifting costs	$509M
Increased rig uptime	$242M
Reduced CapEx/cost-escalation	$122M
Increased drilling efficiency	$113M
Improved recovery rates	$98M
Reduced equipment costs	$49M
Improved remote monitoring	$42M
Improved personnel safety	$5M

MIDSTREAM

Fleet operations	$97M
Reduced spillage	$7M

DOWNSTREAM

Intelligent lighting	$62M
Connected marketing	$44M
Next-gen workforce	$18M
Smart refineries	$9M
Smart buildings	$1M

Sum of annual benefits: $1418M
IoE enablement costs: -$425M
Unrealized Value at Stake:* 54%

**= $538M
Annual Profit Increase
for a $50B firm**

*An estimated 46% of IoE Value at Stake is already realized by energy companies.

Source: Cisco Consulting Services, 2015

> "It shows that a next new wave of technology can make things better. We can lift overall global economic activity and also the standard of living for individuals, because it can lower the costs."

Kathy Bostjancic
Director, U.S. Macro Investor Services,
Oxford Economics

IoE Adoption Fuels GDP Growth

For more insights, please visit
http://cs.co/og-gdp

- The No. 3 area of IoE value—reduced cost escalation in greenfield projects—arises from enhanced risk management enabled by a connected supply chain featuring wireless sensors, networked mobility, and Big Data. This represents a $122 million annual margin increase opportunity for a $50 billion firm.

Other leading drivers of IoE value include improved drilling efficiency ($113 million annual value opportunity), higher recovery rates ($98 million annually), vehicle fleet operation optimization ($97 million annually), and intelligent lighting ($62 million annually).

To claim their share of IoE's Value at Stake, oil and gas firms must maximize their ability to turn data into actionable insights. As we have seen, the solution lies in aligning "people, data, process, and things," along with the IT and OT elements of the business.

IoE Adoption by O&G Industry Could Spur Global GDP Growth of up to 0.8%—or $816 billion—by 2025

The impact of oil extends far beyond the O&G industry. For example, TIME Magazine recently estimated that the decline in oil price from $107 a barrel in June 2014 to under $50 per barrel in early 2015 was equivalent to a $125 billion tax cut for Americans. In the same article, it also stated that due to the oil price plunge, American households with oil heat were in position to save $767 each in winter 2015.[40]

Because the ebb and flow of oil touches virtually everyone across the globe, Cisco Consulting Services and Oxford Economics teamed to study the potential macroeconomic effects of IoE adoption by the oil and gas industry over the next decade (2016-2025). [See sidebar, next page]

Oxford Economics began by incorporating Cisco's $600 billion IoE Value at Stake estimate for the next decade (including productivity gains, reduced OpEx and CapEx, and IoE adoption cost of $180 billion) into its Global Economic Model.

The analysis shows that the largest macro impact from IoE adoption comes via the production/supply channel. Cisco Consulting Services forecasts that global oil supply will rise an additional 4 percent (above any expected increase) by 2025 as marginal costs for the industry are greatly reduced, inducing a sharp ramp-up in production. Greater oil output would create an upstream revenue uplift for the industry.

The increased oil supply would also place sizable downward pressure on oil prices. Oxford's model forecasts that the price for Brent crude oil would drop to somewhere between $75 and $85 per barrel by 2025 (compared with $105 per barrel in Oxford's baseline estimate). In turn, however, stimulated by the drop in oil prices, global demand for oil would steadily rise over the next 10 years, resulting in a 3.7 percent boost by 2025 (in addition to any expected increase).

How Digital Transformation in Oil & Gas Can Fuel Global GDP

Industry-wide adoption of Internet of Everything (IoE) solutions could boost GDP as much as 0.8%

up to **$816B**
GDP benefits by 2025

Oil & Gas Firms Invest in IoE

Increased uptime

Higher rates of recovery

More efficient refineries

Reduced costs from asset monitoring, workforce efficiencies, improved logistics, and more

Increased Investments Boost Production and Supply

4% increase in supply from IoE improvements

Consumer Demand Increases

High Production / Low Prices Stimulate Global Economy

This "positive supply shock" triggers additional impacts such as increased economic activity and higher employment so that by 2025, **consumer and business spending grows**

up to **1.5%**

adding billions to the global economy

3.7% increase in demand as greater supply causes prices to drop

Source: Oxford Economics, 2015; Cisco Consulting Services, 2015

> "Cisco Consulting Services estimated that the adoption cost of the Internet of Everything would be about $180 billion for the industry. Over a 10-year period, the multiplier impact would be about three to four times when it's translated to the global economy. That's quite a positive multiplier impact."

Kathy Bostjancic
Director, U.S. Macro Investor Services,
Oxford Economics

The sharp surge in oil supply and the commensurate drop in oil prices would produce a "positive supply shock" for the global economy. Lower oil prices stimulate more real (inflation-adjusted) aggregate spending on goods and services. Most of the gains would be realized through the consumer sector, though businesses would also benefit from lower oil prices as input costs are reduced.

As a result, Oxford Economics predicts that global real (inflation-adjusted) GDP would increase by somewhere between 0.5 percent and 0.8 percent (or $552 billion to $816 billion) by the end of 2025.

Oxford also projects that global consumer spending (in inflation-adjusted real dollars) would be 0.8 percent to 1.5 percent higher than the base-case forecast by 2025, adding $441 billion to $823 billion. This aggregate increase includes a "second round impact" of higher economic activity, raising overall employment (and decreasing unemployment) around the globe.

From a macroeconomic perspective, it is remarkable to see how an estimated IoE investment of about $180 billion by the O&G industry yields such a powerful multiplier impact on the global economy. Oil and gas companies that make IoE investments enjoy direct productivity and efficiency gains, but perhaps more important, they ensure their survival in an environment where oil prices could stay depressed for a long time. Moreover, these companies also benefit from increased demand for O&G goods and services as the global economy expands significantly.

How to Get Started

Here are five areas that firms should begin addressing now to ensure both short- and long-term success:

Build on Your Digital Foundation

Digital transformation demands that oil and gas companies leverage IoE to become more hyper-aware, predictive, and agile. These traits will enable O&G firms to innovate faster and achieve their desired business outcomes. Success requires application of this framework across technology (data), people, and processes.

Technology (Data): Fund data management and analytics as a business case at the enterprise level. Strive to ensure availability of high-quality, actionable, trusted, and complete data. This includes integrating structured transactional and sensor data with a variety of other data types, including text from content repositories, web clickstreams, customer interaction text from non-social networks, mobile devices, geospatial sources, and rich media. Develop advanced analytics tools for predictive statistical analysis or data mining.

People: Build skills in advanced analytics (see "Develop and Attract the Workforce of the Future" below), and complement those capabilities with a culture of collaboration. Apply analytics-driven insights to management

decision-making. Work with data scientists and the business to ensure that data analytics align with business objectives.

Processes: Emphasize development of governance and performance measurement capabilities, internally or externally. Governance skills are critical to ensure proper deployment of data analytics. Also, create processes for information management and application development, along with information consumption.

Develop and Attract the Workforce of the Future

To become agile enough to compete in the IoE Era, the oil and gas workforce must possess an optimal mix of technical skills, industry knowledge, and business acumen. With talent shortages due to massive numbers of trained executives and other professionals retiring over the next few years, O&G firms need to make bold moves to transform their workforce strategy.

One approach is to take advantage of IoE-based technologies such as video conferencing to train current and new employees. Oil and gas firms also must work hard at developing or attracting employees who can see across IT and OT (also see the next section, "Align and Integrate IT and OT").

Automation offers an opportunity to reduce overhead of some repetitive tasks, while opening up opportunities to bring in critical thinkers with analytical skills such as data scientists. The primary role of the data scientist is to identify data that has real business value—and to develop the delivery path for information into the right parts of the business. Data scientists need to understand business and industry implications to derive the types of insights that could significantly impact the bottom line. The race for talent in this area bridges multiple industries; O&G firms should begin competing now to attract this talent or risk being left behind.

Align and Integrate IT and OT

As described earlier in this paper, O&G firms will truly improve end-to-end business efficiency only when they enable integrated planning and operations across the silos that currently divide the IT and OT aspects of the business. Oil and gas companies must begin to build a culture of communication, collaboration, and coordination between these teams, strongly supported by company leadership.

One approach is to establish a center of excellence that spans IT and OT to govern digital architecture and standards. This provides an opportunity for members to communicate intentions, and to expand participation from all relevant entities. The goal should be to align skills, language, and strategy—even before architecture and technology.

Ensure End-to-End Cybersecurity

To help mitigate cybersecurity risks, as well as prepare for future industry developments, oil and gas firms should do the following:

> "I believe that the oil and gas companies that seek innovation, that are becoming more efficient, reducing costs, and actually doing things about it now, not only are they going to be better off today, but just think about how well they'll be positioned for the future. And my advice to them is that, if you don't have operational efficiency today, you better get it."
>
> **Chris Niven**
> Research Director, IDC Energy Insights

> "For the first time, pressure is being brought to bear on organizations across the globe to reengineer the way they do things, and that requires a lot of thought. It requires the bringing together of technology and people."

Graham Hill
EVP, Global Business Development & Strategy, KBR

Business-Driven Re-Engineering

For more insights, please visit
http://cs.co/og-reengineer

Establish the Baseline: Take a comprehensive inventory of all assets and their current state. Design defenses based on the premise that a successful attack is inevitable. Defensive capabilities are required before, during, and after an attack.

Achieve Visibility: Ensure visibility of the assets, protocols, users, applications, and traffic patterns on the control network to develop a picture of what is "normal" for that environment. This can be done without disrupting real-time communications, and so that loads on sensitive OT devices are not increased.

Implement Controls and Automation: Prioritize assets and systems based upon their value to maintaining operations, and build out defenses for the critical assets and systems first. Implement a combination of IT security and IACS (industrial automation and control systems) security to limit the attack surface and attack window as much as possible.

Strive for Continuous Improvement: Regularly test, review, and update defenses and policies. Being "secure" is temporal, as threats and attack techniques constantly evolve. Therefore, defenses should be regularly tested and modified, as needed.

Innovate for Growth

Once oil and gas firms have leveraged IoE to drive the efficiencies referenced earlier in this paper, they can begin looking at other opportunities to foster innovation and growth. Here are some potential IoE-enabled solutions that could create significant value in the future for the oil and gas industry:

Predictive and Prescriptive Analytics: Predictive analytics anticipate future behavior or estimate unknown outcomes. By understanding likely outcomes, organizations can choose alternative courses of action (prescriptive analytics) as well as modify investments to maximize return. Predictive maintenance is one area where predictive analytics can pay large dividends for the oil and gas industry.

Autonomous Field Vehicles: Autonomous field vehicles (AFVs) are unmanned marine, air, or ground platforms that can be configured to deliver a wide variety of sensor payloads to remote locations. AFVs will become increasingly important to oil and gas firms for monitoring extreme operating environments and efficiently conducting high-risk equipment inspections.

Smart Robots: Smart robots have the ability to work autonomously in the physical world and learn from their experiences. They sense conditions in their local environments, recognize and solve basic problems, and learn how to improve. They can also work alongside humans or replace human labor. Like AFVs, smart robots provide an attractive alternative to placing human O&G workers in dangerous locations or situations.

Wearable User Interfaces: Wearable user interfaces can sense the human body or the environment around the wearer, and then transmit relevant information to a smartphone or the cloud. Examples of wearable electronics include smart watches, smart glasses, smart clothing, fitness monitor wristbands, sensors on the skin, and audio headsets. Wearables have significant potential to improve the safety of oil and gas workers based in remote locations. They can also streamline workflow by enabling field workers to access technical information pertaining to a specific piece of OT equipment in real time. In addition, adoption of wearable technologies will help attract the younger, tech-savvy workforce of the future.

Cognitive Computing: Cognitive computing involves self-learning systems that use data mining, pattern recognition, and natural language processing to mimic the way the human brain works. The goal is to create automated IT systems that are capable of solving problems without human assistance. Cognitive computing will improve knowledge workers' decision-making ability by automating access to information and by highlighting risks and uncertainties. In the future, cognitive computing could impact not just the nature and structure of organizations, but how they achieve competitive advantage.

When the price of oil stood at more than $100 per barrel, the need for oil and gas companies to improve operational efficiencies was primarily driven by the competitive marketplace—and many firms took no action at all. With the oil-price collapse of 2014-2015, however, increased efficiency has become a business imperative that will determine both survival and competitive advantage. The time for oil and gas companies to act is now—through a strategic transformation underpinned by a new approach to people, process, and technology.

> "Oil companies are moving toward what we refer to as 'manufacturization.' The idea is to set standards for processes, for technologies, and create an environment that is standardized with repeatable processes so that you can create KPIs and benchmarks that allow you to measure and monitor performance."
>
> **Chris Niven**
> Research Director, IDC Energy Insights

Acknowledgements

1. Operational Technology (OT) is technology used in specific operational processes, such as supply chain, manufacturing, and transportation. In the oil and gas industry, operational technology is also referred to as "industrial control systems" (ICS).
2. Cisco defines "Value at Stake" as the potential bottom-line value (higher revenues and lower costs) that can be created or will migrate among companies and industries based on their ability to harness IoE.

3. The 50 industry executives, consultants, and analysts represented: **14 countries:** Australia, Canada, China, France, Germany, India, Malaysia, Nigeria, Russia, Thailand, Turkey, United Arab Emirates (UAE), United Kingdom, and United States; Virtually **all segments of the oil and gas value chain**: development (36%), exploration (30%), production (22 percent), pipeline (6%), refining/petrochemical (4%), and transport/storage (2%); Current oil and gas company **C-suite executives** (60%), industry **consultants** (24%), industry **analysts** (8%), and oil and gas executives retired in the last five years (8%); A range of senior management roles: corporate officer, such as **COO or CIO** (43%); **director** (37%); **vice president** (13%); and **senior vice president** (7%); **Line of business/OT**[41] (58%), **IT**[42] (22%), and "other"[43] relevant functions (20%)

4. CNBC, March 18, 2015; Oil-price-net, March 19, 2015.

5. The Motley Fool, March 15, 2015; LexisNexis Legal Newsroom; Business Insider, March 18, 2015.

6. "Oil Price Crash a Blessing in Disguise for U.S. Shale," Oilprice.com, March 9, 2015.

7. Sources: EIA, Baker Hughes

8. Source: Oilprice.com

9. "U.S. Drillers Scrambling to Thwart OPEC Threat," Associated Press, March 23, 2015.

10. Sources: Analyses by consultants ITG Investment Research, Wood Mackenzie Ltd., and Rystad Energy; "ConocoPhillips CEO Bets Farm on Shale, Sees Oil Rebound," BloombergBusiness, April 8, 2015.

11. "U.S. Drillers Scrambling to Thwart OPEC Threat," Associated Press, March 23, 2015.

12. "How Forward-Thinking Oil and Gas CIOs Should Approach Price Declines," Gartner, December 3, 2014.

13. "Oil Price Crash a Blessing in Disguise for U.S. Shale," Oilprice.com, March 9, 2015.

14. "Digital Oilfields," PetroWiki.

15. "A CIO's Guide to Using Gartner's Digital Oil Field Framework," Gartner, October 15, 2014.

16. In a separate study, Cisco asked the same question to 1230 respondents across multiple industries, including oil and gas. The results were similar: "Data" ranked No. 1 (40 percent), followed by "Process" (27 percent), "People" (20 percent), and "Things" (13 percent).

17. "Analytics-Powered Performance: Opportunities for Oil and Gas Companies to Improve Business Outcomes," Accenture, 2013.

18. "Attaining IoT Value: How To Move from Connecting Things to Capturing Insights," Cisco, December 2014.

19. "Internet of Things Technologies Could Transform Oil, Gas Industry," Karen Boman, Rigzone, September 1, 2014.

20. "Attaining IoT Value: How To Move from Connecting Things to Capturing Insights," Cisco, December 2014.

21. The Internet of Things (IoT) comprises networks of physical objects and connected sensors that automate operations by 1) gathering information automatically about physical assets (machines, equipment, devices, facilities, vehicles) to monitor status or behavior, and 2) using that information to provide visibility and control to optimize processes and resource use, and to improve decision-making. IoT is an enabler of the Internet of Everything (IoE) ecosystem, which incorporates people in addition to data, process, and things. The "people" component of IoE typically fuels a variety of collaboration-based solutions; IoT-driven solutions, on the other hand, comprise data, process, and things, but not people.

22. "IDC FutureScape: Worldwide Oil and Gas 2015 Predictions," IDC, January 2015.

23. "How Forward-Thinking Oil and Gas CIOs Should Approach Price Declines," Gartner, December 3, 2014.

24. "Analytics-Powered Performance: Opportunities for Oil and Gas Companies to Improve Business Outcomes," Accenture, 2013.

25. "IDC FutureScape: Worldwide Oil and Gas 2015 Predictions," IDC, January 2015.

26. "Top 10 Technology Trends Impacting the Oil and Gas Industry in 2014," Gartner, March 31, 2014

27. "Top 10 Technology Trends Impacting the Oil and Gas Industry in 2015," Gartner, March 18, 2015

28. Gartner defines "IT-OT Convergence" as follows: IT/OT convergence is defined as a measure of how dependent the OT infrastructure is on standard IT components such as platforms, network connectivity, and data formats. IT/OT alignment is the degree to which management of the two technologies is aligned." Source: "Hype Cycle for Upstream Oil and Gas Technologies, 2014," Gartner, July 28, 2014.

29. "Hype Cycle for Upstream Oil and Gas Technologies, 2014," Gartner, July 28, 2014.

30. "Building the Business Case for Industrial Ethernet," Aberdeen Group, April 26, 2011

31. "Innovation in Oil and Gas: Overcoming Conventional Approaches to Unconventionals," Roland Berger Strategy Consultants, November 2014.

32. "Finding Common Ground in Oil and Gas," IBM Institute for Business Value, 2014.

33. "Oil and Gas Contractor Improves Global Operations," Cisco Case Study, June 2014.

34. "2014 Oil & Gas Outlook," Deloitte, 2014.

35. "IDC FutureScape: Worldwide Oil and Gas 2015 Predictions," IDC, January 2015.

36. "Top Ten Technology Trends Impacting the Oil and Gas Industry in 2015," Gartner, March 18, 2015.

37. "DHS Report: Energy Sector Now a Bigger Target for Cyber Attackers," The Wall Street Journal, June 28, 2013.
38. "Cyber Security: 60 Percent of Oil and Gas Companies Do Not Have an Incident Response Plan in Place," Fox-IT, February 3, 2015.
39. Please see "Value at Stake" definition in endnote No. 2.
40. "The Cost of Cheap Gas," TIME Magazine, February 2, 2015.
41. "Lines of business" includes capital projects, CEO, manufacturing, operations (including plant operations), production, quality, risk management, safety & security, and supply chain.
42. "IT" includes IT, innovation, and R&D.
43. "Other" includes geology, engineering, and exploration.

Scan and
Visit to
Learn More

CISCO