White Paper

The Connected Oilfield

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Introduction

The oil and gas industry relies on information and communications technology (ICT) to meet its business goals. The industry recognizes that to manage future oil and gas developments and the effective production of existing reserves, it will be essential to integrate and connect business processes, geographies, and organizations. The use of collaborative environments will become a prerequisite, allowing oil and gas experts around the world to assimilate and interrogate large volumes of data and information to make informed, right-time[1] business decisions. These environments, which define the connected oilfield, must be designed around a "human network"; in other words, the environment must connect all stakeholders, such as field staff, technical experts, and knowledge workers, if they are to function effectively.

Clearly, change is coming to the oilfield, as the Society of Petroleum Engineers commented in a recent position paper: "Over the next decade the way in which we understand our reservoirs, identify development options, manage and optimize our wells, facilities, and associated production will all change radically. Logically this leads to...a substantial impact on the people working on these fields."[2] With change comes the promise of significant rewards to those who have made the investment in business transformation based on information and communication technology.

Ultimately, connecting oilfield assets and stakeholders with real-time and right-time information will facilitate distributed problem solving and decision making, and enhance effective asset management. The consequential improvement in recovery rates, together with better cost management and improved health, safety, and environmental performance, will help the industry continue to meet the ongoing hydrocarbon needs of the world's energy consumers.

The connected oilfield is about new ways of working.

What Is the Connected Oilfield?

While the oil and gas industry undeniably focuses a great deal of activity on "digitization of the oilfield," little effort has been expended on the role of the intelligent network as the platform for connecting steakholders with oilfield assets.

The connected oilfield is about "integrating operations"—using IT to change work processes for better decision making, to manage and control equipment and processes remotely, and to move functions and personnel onshore. Integrated operations enable digitally facilitated interactions that deliver business value while simultaneously reducing business, health, safety, and environmental risk.

1. The term "right time" refers to the time frame in which a decision must be made, versus "real time," the time frame required for a widely distributed group to make a decision using conventional technologies. In the connected oilfield, a balance between real time and right time must be preserved.
2. "Making Our Mature Fields Smarter: An Industrywide Position Paper from the 2005 SPE Forum Society," Society of Petroleum Engineers, 2006.

Having a network is not sufficient; it must be an intelligent network that truly can act as a central nervous system, connecting every individual and every function in the organization, while permitting collaboration and data sharing with the greater oil and gas ecosystem. This means that time zones and geographical distance are no longer barriers. It delivers true "sense-and-respond" capabilities, which allow oil and gas companies to manage workflows across geographies, enhance collaborative environments, and monitor and manage fixed and mobile assets at the right time, in the right place, with the right resources.

The intelligent network will facilitate the seamless integration of data, information, and work processes. It creates a virtual environment where effective communication and collaboration among experts can occur, regardless of where the experts are physically located or to which organizations they belong. An intelligent network means the connected oilfield knows no internal, limiting boundaries, and delivers information that will result in the improved recovery of hydrocarbons, more efficient oilfield operations, and increased productivity. At the most basic level, the ability to recalibrate a pressure gauge remotely imparts data that can be shared and incorporated in the decision-making process in a matter of minutes—instead of hours, days, or weeks.

The intelligent network provides for the human element. In the exploration and production business, critical decisions are based on the assembly and consolidation of knowledge as it is interpreted by technical professionals—knowledge workers who need help visualizing potential solutions and outcomes. Sophisticated visualization tools being developed for the connected oilfield will aid collaboration in real time, as well as in right time.

By facilitating the "borderless organization," the connected oilfield supports new ways of working.

Addressing Industry Opportunities and Challenges—The Promise of the Connected Oilfield

Oil and gas is one of the few truly global industries—particularly exploration and production. It is also one of the most knowledge-intensive industries. It relies on professional workers to make and implement key value decisions. Business needs and pressures, coupled with rapid advances in ICT capabilities, are promulgating a digital evolution—indeed, a revolution. Understanding and using connectivity and connectedness between assets, workers, and all stakeholders is a critical requirement.

A recent position paper issued by the Society of Petroleum Engineers implicitly supports the need for connectivity to enable what it labeled the "Smart Field." The paper noted that "The underlying and critical enabler for the Smart Field is the relentless, rapid, and massive increase in digital capability..."[3]

3. Ibid.

The Benefits of Integrated Operations*

Production Increase:

- Real-time interaction between involved activities and disciplines. For example, engineers monitoring compressors or wells from land can contact the field if they discover matters requiring action.
- Use of dynamic simulation in connection with production and process analyses.
- Use of analysis tools in critical work processes, where the tools extract and present available information from operating data (both historic and near-real-time data). One example is detection of scale in a well as a function of changed ratio between calculated influx and pressure conditions. Another example is an analysis of correlation between flare rate, wellhead, and manifold pressure, which indicates which well is causing flaring. Such information can be hard to grasp without special aids.
- The use of interaction rooms to support work processes between land and sea, and between operator and supplier (the measure also includes drilling, operations, and maintenance). There are many examples of how interaction rooms create production increases. Production issues can be solved earlier through prompt involvement of support functions and experts who can quickly implement the right measure. In some cases, work can be performed from such rooms that would otherwise have necessitated travelling to the installations.
- Continuous control/support from onshore specialists—from both the organization and its suppliers—on a 24-hour basis

Reserve Increase:

- Consistent production and reservoir data (including seismic data)
- Accurate reservoir models for optimal localization of wells
- Smart wells, and real-time reservoir monitoring and management

Reduced Operating and Maintenance Costs:

- Condition- and campaign-based maintenance
- Transferral of administrative, surveillance, management, and reviewing activities onshore
- Reduced usage of experts offshore
- Onshore remote control
- Increased instrumentation and automation, and improved efficiency for monitoring and analysis
- New ways of supporting the fields by centralizing tasks, coordinating across fields, and specializing service supplies to a larger degree

Reduced Drilling Costs:

- Fewer sidetracks with more accurate drilling
- Real-time optimization of path and drilling processes
- Reduced need for sending out specialists and service personnel

* Source: "Potential Value of Integrated Operations on the Norwegian Shelf," Norwegian Oil Industry Assn. (OLF), April 2006.

Opportunities

An often-quoted study by Cambridge Energy Research Associates (CERA), which examined the likely advantages of integrated operations based on data from reservoir, down-hole, and surface facilities, estimated some of the key benefits as:

- Improvement in ultimate (hydrocarbon) recovery: 1-7 percent
- Production acceleration: 1-6 percent
- Reduction in downtime: 1-4 percent
- Improvement in operating efficiency: 3-25 percent
- Drilling cost reduction: 5-15 percent[4]

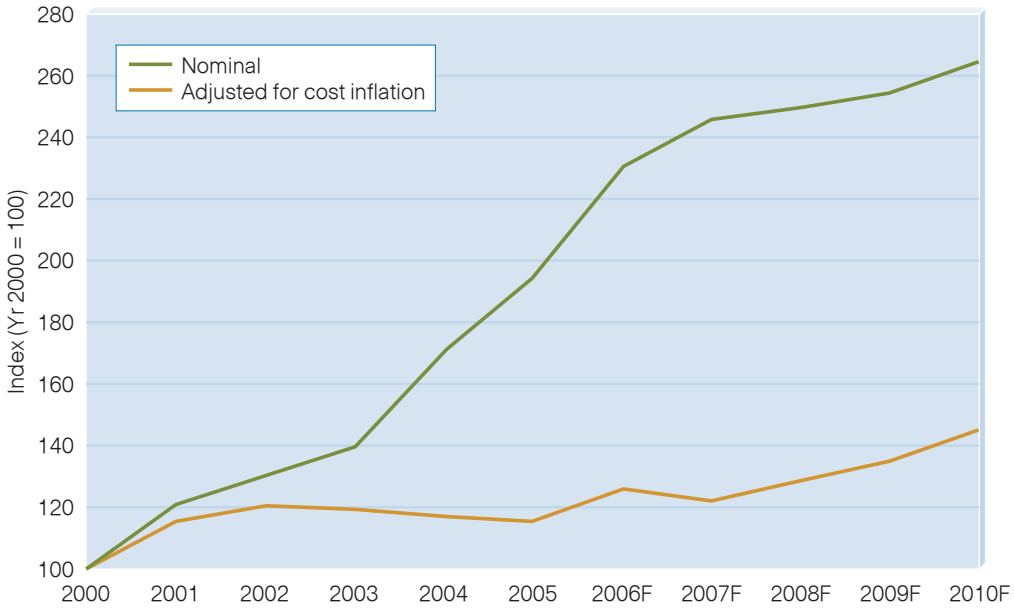
As oil and gas companies engage in their digital oilfield studies and pilots, and as they look to connect and integrate all the disparate data and communication flows, they find they have a single common need: connectivity, defined as the ability to integrate data and information seamlessly with workflows, processes, and people in a "borderless" manner across legacy systems, organizations, and country borders.

Challenges

Cost Reduction: The energy industry is cyclical, driven by expectations of the current and future price of oil and gas. Prices are driven by basic supply and demand, created by world macroeconomics. When oil prices are high, the industry invests in skills and capabilities (usually at the peak). When the price of gas and oil is low, the industry stops investing. Unfortunately, the timing is never quite right, leading to cyclical volatility in capacity and in the price of materials and services. The result is that the oil and gas industry is often painfully short of capacity and skilled workers just when they are most needed. The resulting capital expenditures (CapEx) and cost inflation are likely to continue, as is illustrated by projects and forecasts from the International Energy Agency, among others.

4. "The Digital Oilfield of the Future: Enabling Next Generation Reservoir Performance," Cambridge Energy Research Associates, Inc., 2003.

Figure 1. Global Upstream CapEx and Cost Inflation



Index was forecasted for years 2006-2010.
Source: IEA World Energy Outlook, 2006.

Environmentalism: The world wants more gas and oil for energy transport, and for manufacturing the goods and commodities that consumers demand. Yet there is also a growing desire to improve the environmental performance of the energy industry to reduce carbon emissions and to protect ecologically pristine or fragile environments. How can the industry reduce its carbon emissions, protect the environment, and still produce and use more gas and oil?

"The Big Crew Change": As previously noted, the gas and oil industry is one of the world's most knowledge-intensive industries. Many of the key business value decisions are made on the basis of interpretation of data by people with highly specialized expertise. The skill demographic for the industry is lagging, however, especially for regions like North America. As the current workforce ages, a few things come into play. First, older workers (having served their time around the world) are not inclined to journey to the Arctic wasteland or to remote and dangerous jungles. Increasingly, they would prefer to share their expertise from a clean and comfortable office. Second, many of these older workers are retiring. Some may choose to consult after retirement, but they are unlikely to move around the world to new locations as they do so. Third (and most critical for the industry), there are not enough people entering the workforce with the right kind of training and education. As a result, competition for access to knowledge and skills has become increasingly fierce. How can the energy industry retain or improve access to skilled workers while allowing them to maintain the quality of life they desire?

These challenges are well known and the potential prize is huge. The network and associated ICT technologies can play a greater role in helping the oil and gas industry achieve these goals. These truly are connected opportunities that require a connected paradigm.

The Connected Oilfield: A Scenario

Consider a common situation where tools are stuck down the well and the inability to contact the expert—the drilling manager—is causing the rig to remain idle at a cost of several hundred thousand dollars per day. Or, what if the offshore team believes the drill bit for the horizontal well currently being drilled has just passed out of the reservoir formation? Reservoir engineers in Houston need the logging-while-drilling (LWD) data from the rig (which they are not as yet aware is down). Many more problems and miscommunications can ensue from this situation—all because the company's entities are organizationally, geographically, and culturally unconnected. Here's what that scenario could look like today using intelligent network technology, also known as the connected oilfield:

Robert Frank is the asset manager for an in-situ development in Athabasca, Canada. The crew is drilling a complex, deviated horizontal well that is being steered through a 10-meter-thick payzone to maximize the contact area. From real-time sensor and LWD, MWD (monitoring-while-drilling) data, the drilling team believes they have encountered an unexpected fault that has pushed the drill bit out of the payzone and caused it to become stuck. The down-hole sensors suggest that if they put too much torque on the drill bit, it will break, requiring a costly fishing expedition to recover the bit and tools. The project already is overbudget, and any downtime will cost Frank US$100,000 per day.

Fortunately, the well site is fully instrumented and has state-of-the-art Unified Communications capabilities, including a single-screen TelePresence setup. Unified Communications employs voice, video, data, and mobility products that enable businesses to share information more quickly and effectively, improving productivity and reducing costs.

To solve the problem, Frank needs to communicate and collaborate with Kim Hansen, who is part of the subsurface team in Houston; Andrea Kelly, who was involved in designing the well; and Mike Contreras, who is currently in Stavanger, Norway. Mike is a highly experienced drilling manager with 30 years of experience, and he's seen it all before.

Frank uses Unified Communications to locate these experts. He also identifies their availability and current preference for communications ("presence"). Hansen is available and prefers e-mail, so this is how Frank initiates the dialogue. Kelly is temporarily unavailable, but her preference is the phone. Frank leaves a voicemail message for her. Contreras is available and also prefers e-mail, so Frank sends an e-mail message that is picked up on Contreras' PDA. Frank sets up a TelePresence meeting request and receives acceptances in less than 10 minutes. The ability to understand the presence profile of each of the experts has been critical.

One of the key capabilities of this connected oilfield is that it is equipped with sense-and-respond capability. Through the use of sensors, together with wireless technology solutions such as first mile wireless, real-time data capture, analysis, and alerting capabilities have been established. This meets the challenge of capturing and transmitting the data from remote locations, which often are poorly served by traditional communications infrastructure. This allows Frank and his team to respond to these unplanned, real-time events as they unfold, at the right time, in the right place, with the right resources.

One hour after Frank's initial communication, all four experts are sitting in their respective TelePresence rooms, ready to collaborate on solving the production well problem. At the touch of a button, Frank initiates the session and the team members interactively share ideas, data, and documents in a virtual, face-to-face setting, in real time.

One of the disadvantages imposed by team members being remote from one another is the lack of synergy that person-to-person meetings bring. The immediacy of TelePresence overcomes this challenge. Because of the rapport developed during the TelePresence session, the team identified a number of potential innovations that could enhance ultimate recovery by 2 percent.

Connecting the Oilfield

The oil and gas business is about acquiring and managing assets, whether in the Gulf of Mexico, Fort McMurray, Canada, or Eastern Siberia. It's about making value decisions, such as where to drill next and how best to maximize production. It's about linking, coordinating, and ultimately scaling the organization, gaining access to the right skills and resources. And all this must be accomplished safely, with high regard for the health of employees and local inhabitants, as well as for environmental issues.

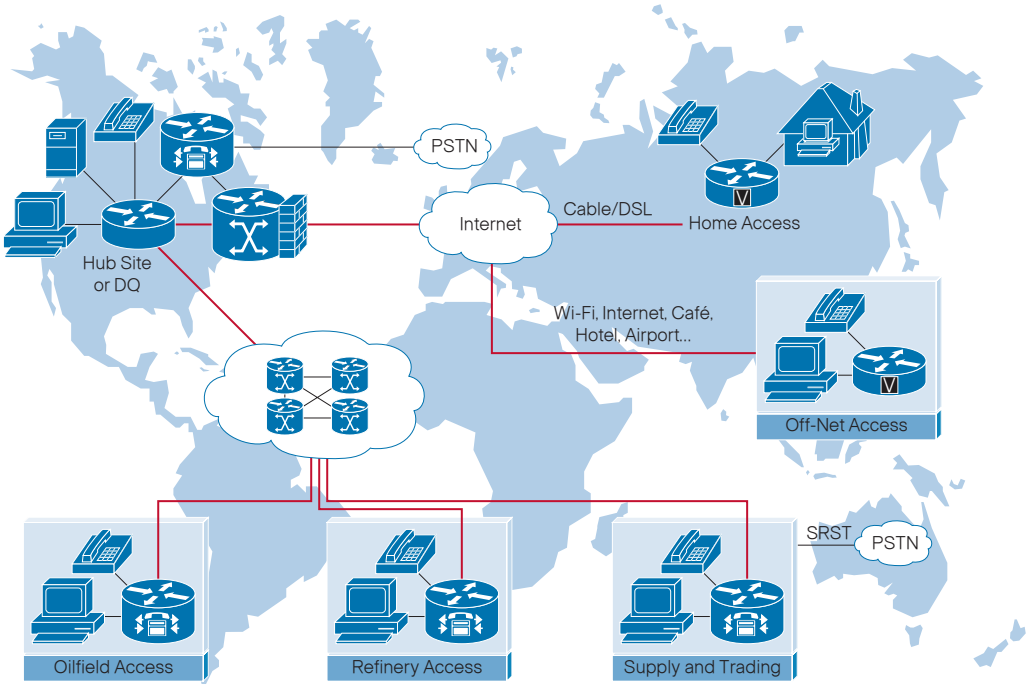
Effectively achieving this requires the management of connections between workflows, processes, and people. But as a consequence of the history and culture of the energy industry, there are geographical, organizational, and cultural fault lines. These fault lines inhibit the ability to collaborate and communicate effectively both in real time and on an ongoing basis.

Distributed Decision Making

A connected oilfield is by definition a "virtualized" or "edge organization" in which decision making is a distributed function. Peer-to-peer exchanges—individuals distributed around the oilfield itself and around the world, communicating digitally—are the everyday transactions of the connected oilfield. In this widely distributed environment, which relies not only on the availability of information, but also on the expertise of individuals to correctly interpret it, tools like remote visualization and Unified Communications are indispensable. An intelligent information network enables these capabilities "at the edge" (for example, for the down-hole sensor or the mobile maintenance worker), and facilitates the virtualization of the sense-and-respond organization:

- **Virtualization:** Giving users access to their communications environment, regardless of location
- **Supporting Rich Media:** Enriching communication through integration of voice, video, and data collaboration
- **Modality:** Support for multiple media types, devices, and bandwidth capabilities

Figure 2. An Intelligent Information Network Enables Capabilities "At the Edge."

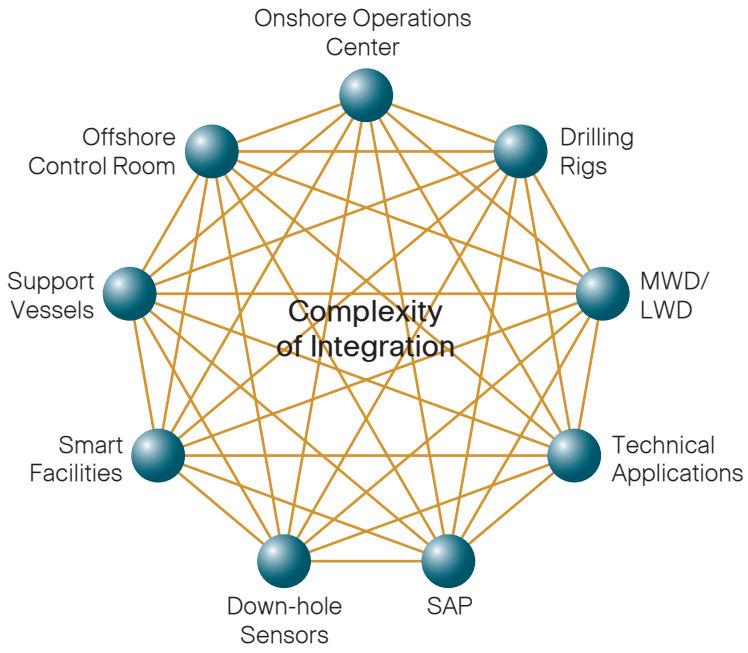


Face-to-face, remote visualization technologies lead to smarter collaborative decision making. When you can see and speak directly with colleagues thousand of miles away, decision making becomes a truly collaborative process that provides an environment for sustainable and ongoing learning.

Collaborative decision making is enhanced through solutions like Unified Communications, which relies on a common IP infrastructure to bring together multiple phones and devices, along with multiple networks (fixed, Internet, cable, satellite, and mobile). In this network-centric world, communication and collaboration will be independent of location, time, or device. Communication will not be dependent on the kind of device workers are holding, or their proximity to a teleconferencing setup. They could have a gauge, a sensor device, or a phone— it makes no difference; all devices are connected by the intelligent network. In this scenario, which already is happening to a limited degree in the not-quite-completely-connected oilfield, the right people are getting the right information at the right time.

IT architecture is the integrating element. The present-day oilfield has no shortage of IT systems and security architecture, but the complex, legacy systems currently in place will not be able to do the job of running the connected oilfield. Service-Oriented Architectures (SOA), and data management schema such as PRODML and WITSML, which repurpose and reuse architectural components across the network, are being developed to address the complexity of the digital oilfield and its management. These data descriptions, however, do little to untangle the complexity of linking the data together and sharing it, with minimal delay, across a virtual community.

Figure 3. The Complexity of Integration Associated with the Digital Oilfield.



IT architecture is the integrating element that helps facilitate the following:

- **Agility—**Intelligence in the network, allowing compute resources to be dynamically redeployed, minimizing the need for additional IT resources. Major changes or upgrades to applications can be handled more efficiently.
- **Increased Service Levels—**Data center resources are pooled, providing redundancy and reserve capacity needed for operational "mission-critical capabilities."
- **Governance and Policy Compliance—**Centralized policies in the infrastructure services layer can be inspected and monitored; decentralized policy enforcement contributes to consistency throughout the organization.

The Intelligent Network Is the Key

The ongoing success of the connected oilfield is dependent on the successful integration of the intelligent network. Great progress has been made to date by the oil and gas production industry in the development of the connected oilfield. The productivity, efficiency, environmental, and safety gains to be made are clear, yet there still is much work to be done. It's the right time to recognize the importance of the intelligent network and incorporate its current and future capabilities into the connected oilfield. All the tools required are ready today.

More Information

The Cisco Internet Business Solutions Group (IBSG), the global strategic consulting arm of Cisco, helps Global Fortune 500 companies and public organizations transform the way they do business—first by designing innovative business processes, and then by integrating advanced technologies into visionary roadmaps that improve customer experience and revenue growth.

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