

Digital transformation in oil and gas

*How innovative technologies modernize
exploration and production*



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The new normal in oil and gas

Oil and gas (O&G) companies are currently experiencing major disruption. It's becoming increasingly difficult to find new sources of oil. As a result, exploration and development investments are progressively made in remote and environmentally sensitive areas, adding significant cost and complexity to capital projects. More stringent regulations are increasing constraints on the business. At the same time a generation of experienced employees are retiring from the industry workforce. Exacerbating the current environment is the precipitous drop in oil price, putting the entire industry under pressure.

Persistent volatility and production oversupply in global energy markets over the past three years, and the resulting significant and sustained depression of oil prices, have



Figure 1: Oil and gas companies look toward digitization to help propel them into the future low carbon economy.

profoundly impacted the entire O&G ecosystem. To thrive in both the current market conditions and the projected future low carbon economy, it will not be enough for most O&G companies to simply enhance the way they currently operate.

Today's market and industry outlook are forcing O&G companies to re-examine core business capabilities, and explore new ways to execute business strategies in a dynamic and volatile marketplace. Whether large or small, national or international, digitalization of key operational workflows in O&G companies will be critical for success in the years to come.

In this whitepaper, we will explain how IBM is taking an industry approach to help clients reinvent themselves to become:

- Highly profitable in a “lower for longer” marketplace
- More productive, even when facing a shrinking workforce
- Renowned for safety, regulatory compliance and environmental excellence
- Resilient and able to grow within a volatile industry ecosystem
- Prosperous within a low carbon economy

Digital transformation creates unprecedented opportunity

Lower crude prices have necessitated a “shift in agility” in which companies must explore and adopt new technology to enable and sustain their exploration, development and production ambitions. Companies once considered conservative and risk averse are now testing and implementing new technology, and also looking at other industries for new ways to significantly improve core processes and decision making.

Implementing necessary changes requires traditional integrated oil companies to address all aspects of the entire value chain, across upstream, midstream and downstream. Success depends on overall improvement, not merely shifting the problem to suppliers or buyers.

We are also seeing the emergence of “Pureplay” companies which specialize in specific parts of the value chain. These companies are driving a change in market dynamics by designing their operations around their specific areas of expertise.

Significant gains can be realized through better optimization of equipment maintenance activities in our industry. New analytics technologies generate timely insight from historical and real-time data to predict failures and optimize maintenance plans. Understanding equipment criticality, costs of maintenance, remaining lifetime and the possible impact on production efficiency can reduce lifting costs and increase the economic life of fields.

Data is recognized as key to drive value. New methods required for new unconventional exploration, seismic technologies and data overload.

300,000

Publications/year

American Petroleum Institute, SPE, AAPG, SGE and others.

80,000 sensors

in a single modern platform
94% of production in 1,500 oil Fields (65,000+)

1-2 TB/day One major O&G company only

2TB/day

Only 5% gets to the shore
95% is not used



Data overload and reliance on traditional, non-scalable methods



Workforce transition and shortage of skills



IoT, data and computationally intensive technologies



Declining giant fields, slow reserve replacement rates



Challenges and risks in new E&P frontiers

Figure 2: Disruptive trends in the O&G industry

How digital transformation drives improvements in exploration and appraisal

IBM believes that now is the time to accelerate digital transformation at both the strategic and operational level, and drive significant improvement in business value realization. Improving output of facilities and wells, streamlining maintenance and turnarounds, and optimizing downstream commodity trading are areas where information technologies create improvements in cost reduction and avoidance, operational uptime and revenue generation.

Key areas within exploration that will benefit from an accelerated digital transformation include:

- Business development—obtaining a competitive information advantage
- License acquisition—assessing the portfolio impact and ensuring strategic fit
- Exploration and appraisal—using information from analogues to reduce uncertainty and valuation risk
- Feasibility assessment and promotion—identifying commercial options and reusable technical concepts
- Well delivery—improving well planning from lessons learned and using real-time data to predict problems during drilling

Perhaps the most important digital transformation opportunity lies in the end-to-end process. While explorers in each step are innovating within their disciplines, the overall process can be transformed by enabling new and better ways of collaborating. Sharing data, refined information and the basis of decision making will make prospects more visible through the various exploration decision gates.



Figure 3: Organization and prioritizing of the end-to-end process makes timetabling production much easier.

From an overall portfolio management point of view, a digital transformation strategy will enable better visibility, planning and de-risking of the organization's current and future reserves. There are large variances in time from technical discovery until first-oil, both across oil and gas companies and resource types. To improve this metric, organizations must address the end-to-end maturation process and the overall portfolio perspective. This will ensure better prioritizing of the areas and prospects with the highest business potential and where new data, technology and capabilities should be applied first.

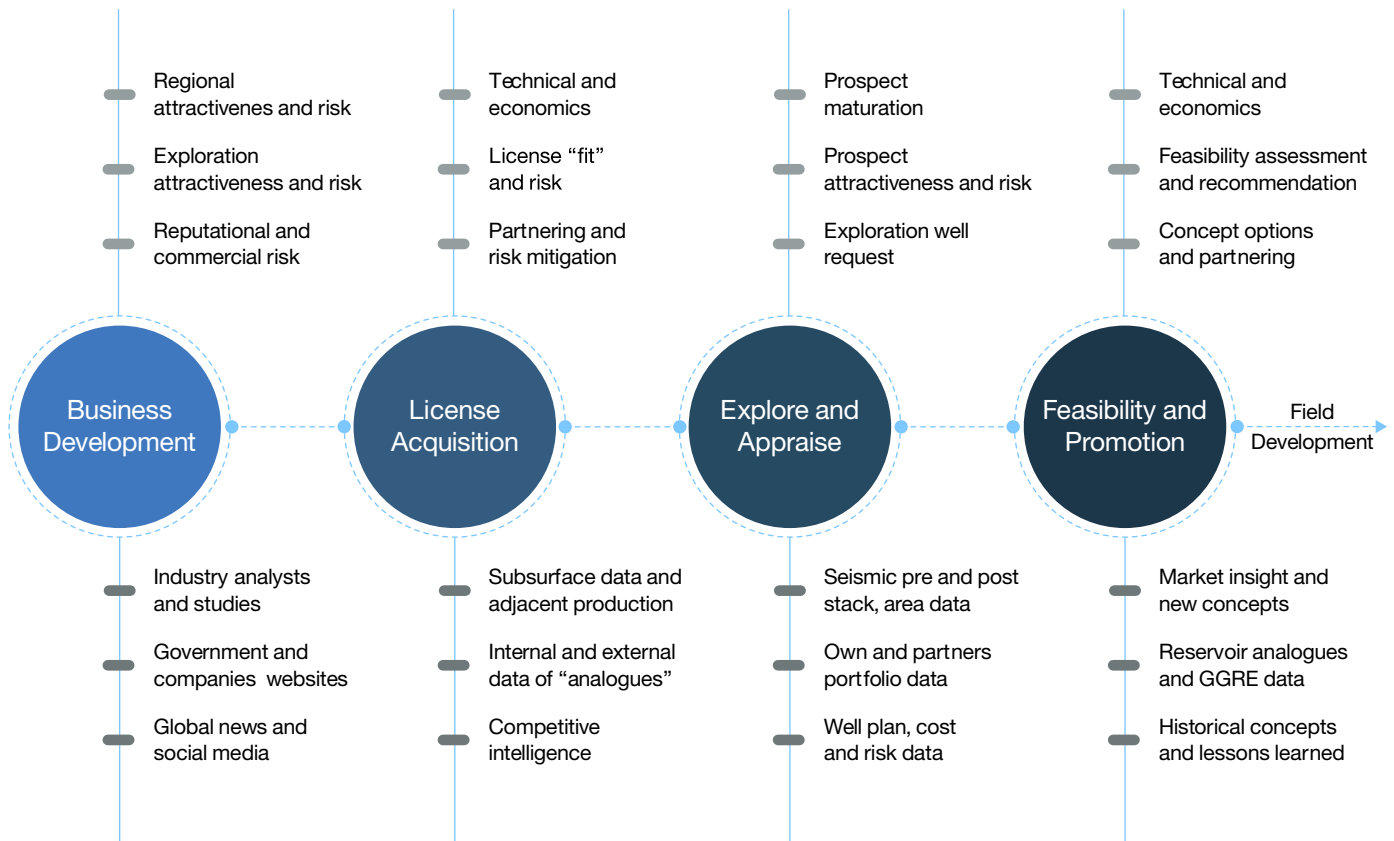


Figure 4: Access, manage and share the volumes, variety, velocity and veracity of exploration relevant data.

Applying digital technologies in development and production

Technology can now deliver “big data” from virtually every aspect of drilling, production, operations and maintenance. The capability to process, analyze and develop insights from data has unfortunately not spread as quickly. As a result, operations are suffering from “avoidable interruption” and lack of optimization. While the digitized oilfield provides an abundance of real-time sensor data, the information is most often used to make immediate, single point decisions on a particular piece of equipment. These include wells or an isolated task. The data is usually not stored, filtered or analyzed to reveal new insight or inform future decision-making. One of the biggest challenges the industry faces today is making data available to decision-makers across disciplines in a way that allows everyone to benefit from it. Instead, data is more likely to be stored in closed-type systems.

The IBM perspective on optimizing the efficiency of operations is comprised of the following guiding principles:

- Oil and gas companies introducing digitalization agendas will find immediate insight and improvement potential from existing, unstructured and new streaming data.
- Advanced insight and better situational awareness can be extracted by applying Cognitive analytics to existing data. Cognitive solutions yield better and un-biased predictions, impact assessment, recommendations and hypotheses.
- Enhanced insight comes from connecting the organization’s data sources with analytics capabilities to create a holistic view of the enterprise operation, from functional details to aggregated impact, e.g. reservoir, well and surface equipment. An analytics platform is required to see, predict, plan, act, learn and continuously improve.



Figure 5: Cognitive analytics enable companies to monitor their operations in real time.

Utilizing Cognitive Analytics and IoT provides the ability to:

- Connect to sensors, devices and equipment, and receive real-time insight and health information
- Predict and prevent issues and failures before they happen utilizing machine learning for constant sweeping of non-obvious patterns
- Harness insights from documents, manuals and correspondence
- Repair more efficiently and effectively with a “cognitive assistant” that provides step-by-step guidance
- Visualize near real-time updates for early warning
- Optimize the use of systems, equipment and people by providing near real-time continuous improvements to operations

The benefits of digital transformation flow through to the bottom line

Exploring and exploiting the right technology, and continuously developing the organization's capabilities, will influence your operation, enable a new way of working, and ultimately define your core business capabilities. The "Digital Transformation" illustration below outlines the playing field to be explored.

The significance of increasing recovery and reducing uncertainty is well known in our industry. The prize is large—increased current cash flow and Net Present Value (NPV)—for reducing risks and capital and operating expenses, increasing recovery and reducing health, safety and environmental exposure. For example, in a Steam Assisted Gravity Drainage (SAGD) operation, IBM developed data driven models and physics-inspired cognitive algorithms to predict emulsion results. IBM utilized non-linear optimization with non-linear constraints to run simulations on historical data, creating the ability to predict emulsion rate days ahead with over 90% accuracy. The operator achieved a material improvement in emulsion production rates, including:

- Better hourly steam injection profile for each well
- Over 13% improvement to cumulative emulsion
- Over 3.5% increase in emulsion volumes

In another example, IBM scientists have also discovered that a drop of oil doesn't look like a drop at all if it is small, to the scale of one billionth of a billionth of a liter, or attoliter. Rather, a nanoscale oil droplet looks more like a flat film against a solid surface. This discovery reveals that the simulation tools and techniques commonly employed by the oil industry do not take into account the increased energy required to extract these oil molecules. And it results in 60% or more of oil being left behind, for example, in the nanoscale capillaries of shale reservoirs. In response, IBM Research-Brazil is developing nanoscience-enhanced oil flow simulations that could better-predict oil extraction from a reservoir. By carrying out those flow simulations in computational three-dimensional representations of actual reservoir rock, the IBM research team is now developing an enhanced oil recovery advisor technology. This includes the computerized design and test of functional materials, such as nanoparticles, for enhanced

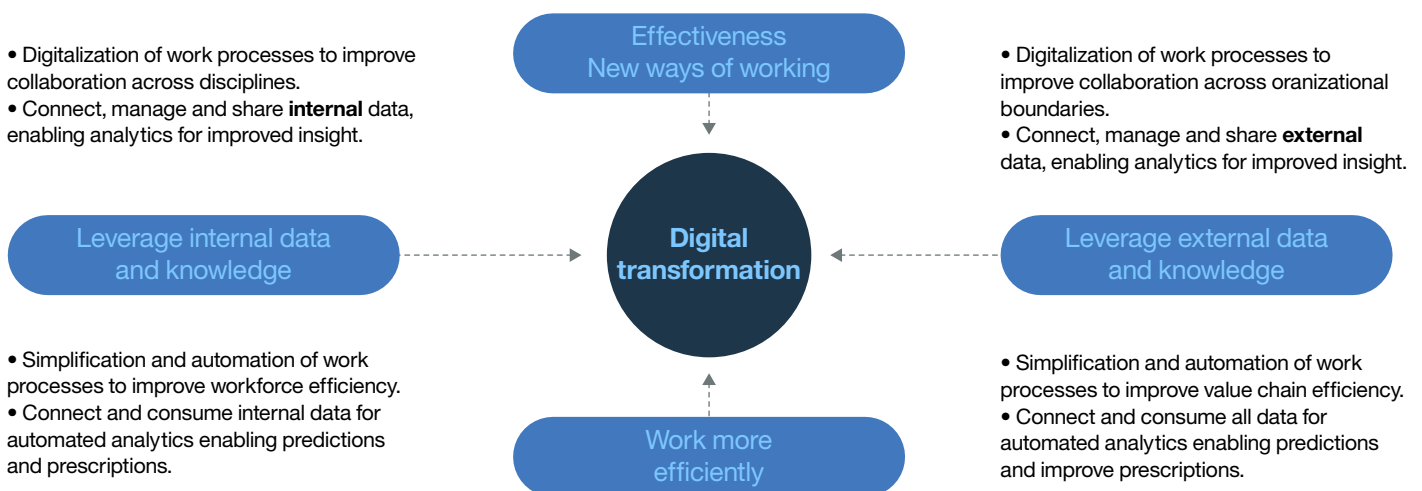


Figure 6: Examples of new ways of working in the digital transformation field.

oil extraction. Provided as a cloud-based IT service, the simulation technology will ultimately generate reservoir-specific recovery recommendations for industry experts who plan and manage oil production.

Digitizing transactions and information sharing through blockchain

Commodity trade finance traditionally requires complex workflows and paper-based processes in which documentation is shared through courier, fax and email exchange. This creates multiple friction points with high processing costs and limited automation.

Natixis, IBM and Trafigura leveraged blockchain’s hyper ledger technology to modernize the crude oil trading process with a shared, distributed, secured and transparent environment for all impacted parties within a single ecosystem.¹

By having the buyer, seller and their respective banks all on the same ledger, all parties can simultaneously view and share data. From the status of a transaction, the time a new trade is confirmed and validated, to when the cruder oil is inspected to its delivery and cancellation of the letter of credit.

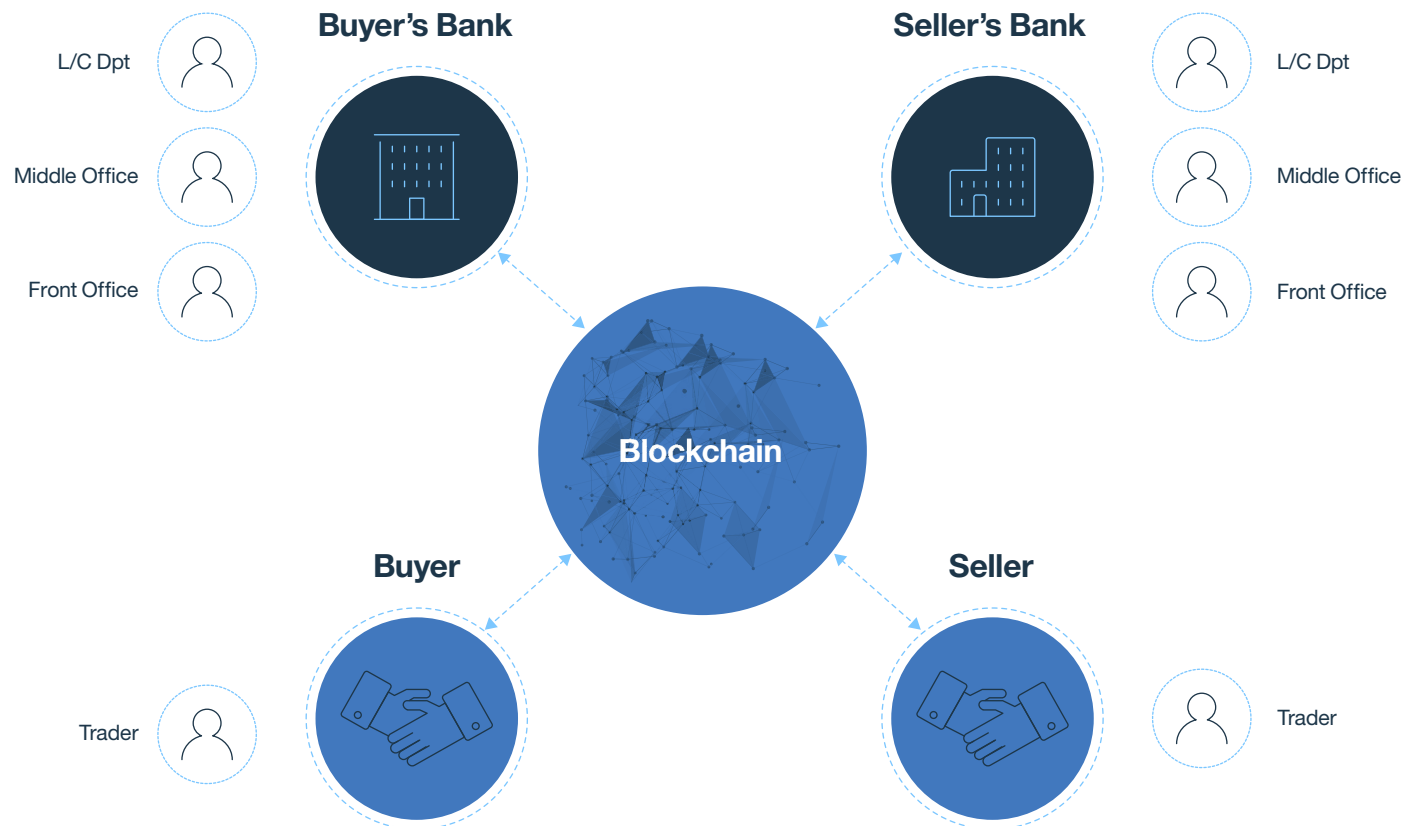
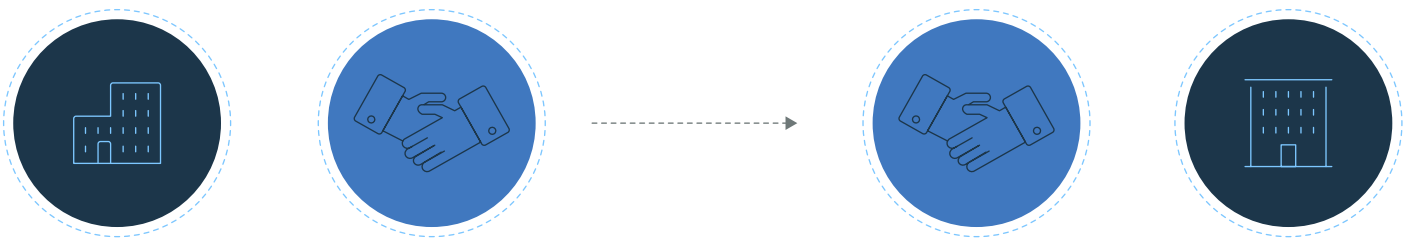


Figure 7: The blockchain shared hyper ledger system.

End-to-end visibility over financing life cycle



14 Step Process

- | | | |
|---|---|--|
| <ul style="list-style-type: none"> ● New trade confirmation ● Trade validation ● L/C Application request ● L/C Application approval ● L/C issuance | <ul style="list-style-type: none"> ● L/C Confirmation from seller ● Guarantee validation ● Transportation & inspection ● Transportation details validation ● Delivery inspection | <ul style="list-style-type: none"> ● Final invoice issuance ● Final invoice validation ● L/C payment issuance ● L/C cancellation |
|---|---|--|

Figure 8: The end-to-end visibility of the financing life cycle.

Key benefits of the solution include:

- Reduced cash cycle times
- Improved efficiency with lower overhead costs and fewer cost intermediaries
- Increased transaction visibility to help reduce the threat of tampering, fraud and cybercrime
- The creation of transparent transactions by using shared processes and recordkeeping.

Accelerating your digital transformation

Are you ready to start your digital transformation journey? As you consider the introduction of digital technologies into your organization, think about these key questions:

- How will your perceived competitive advantages be influenced by new technology?
- Which areas within your organization will be impacted or benefit most from new technology?
- How will you measure success, and secure rapid paybacks?
- What is your plan to encourage and support revenue growth?
- What is your plan to improve efficiency and reduce cost?
- What are your challenges in bringing together data from various sources to solve important business problems?
- How do you include the organization in exploring options and ways to implement digital technologies?
- What new skills or competencies would be required in your organization to take advantage of cognitive computing?

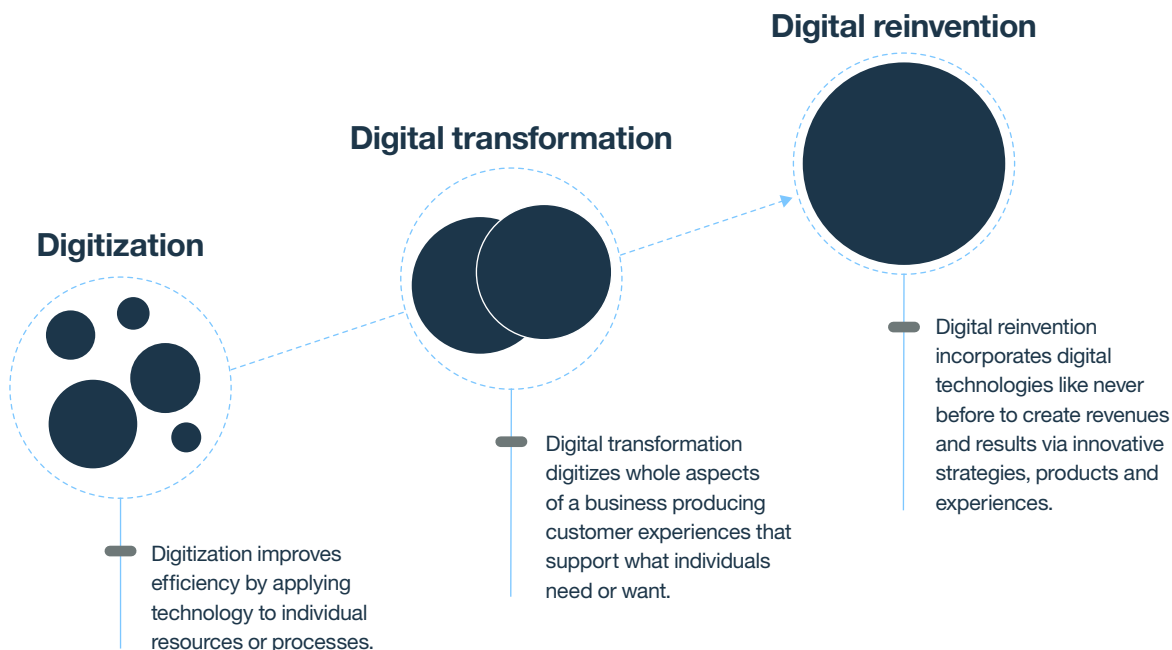


Figure 9: An example of the digitization process.



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