Exploring the power of cognitive IoT

Generating timely action in oil and gas
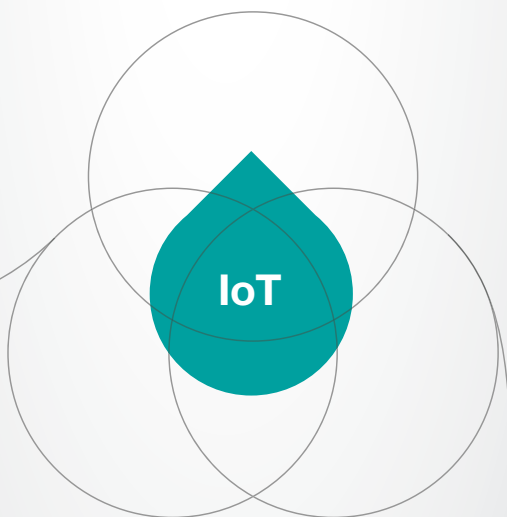
IBM

About the research

In this paper we set out to understand the opportunities that Internet of Things technologies can offer the oil and gas industry, specifically the additional value of cognitive technologies. We wanted to learn from examples, exploring the challenges and learnings shared by early adopters through three key data sources:

• In-depth interviews with 24 IBM subject-matter experts (SMEs), who regularly consult and advise clients across the oil and gas industry, in the USA, Europe, China and Brazil. Their collective industry experience totals almost 400 years and they are quoted throughout this paper

• Client interviews and testimonials from a number of oil and gas companies

• A 2015 study completed by the IBM Institute for Business Value in collaboration with the Economist Intelligence Unit entitled 'A new natural resource: Your cognitive future in the oil and gas industry'. More than 80 oil and gas executives participated in this survey.

The Internet of Things (IoT) has helped the oil and gas industry become more efficient, and yet the ability to make sense of the vast volume of available data, at the precise moment it is needed, remains elusive.

New cognitive technology has the capacity to transform the value of data, whether structured or unstructured, bringing significant operational and strategic benefits beyond pattern identification, to deliver powerful real-time recommendations.
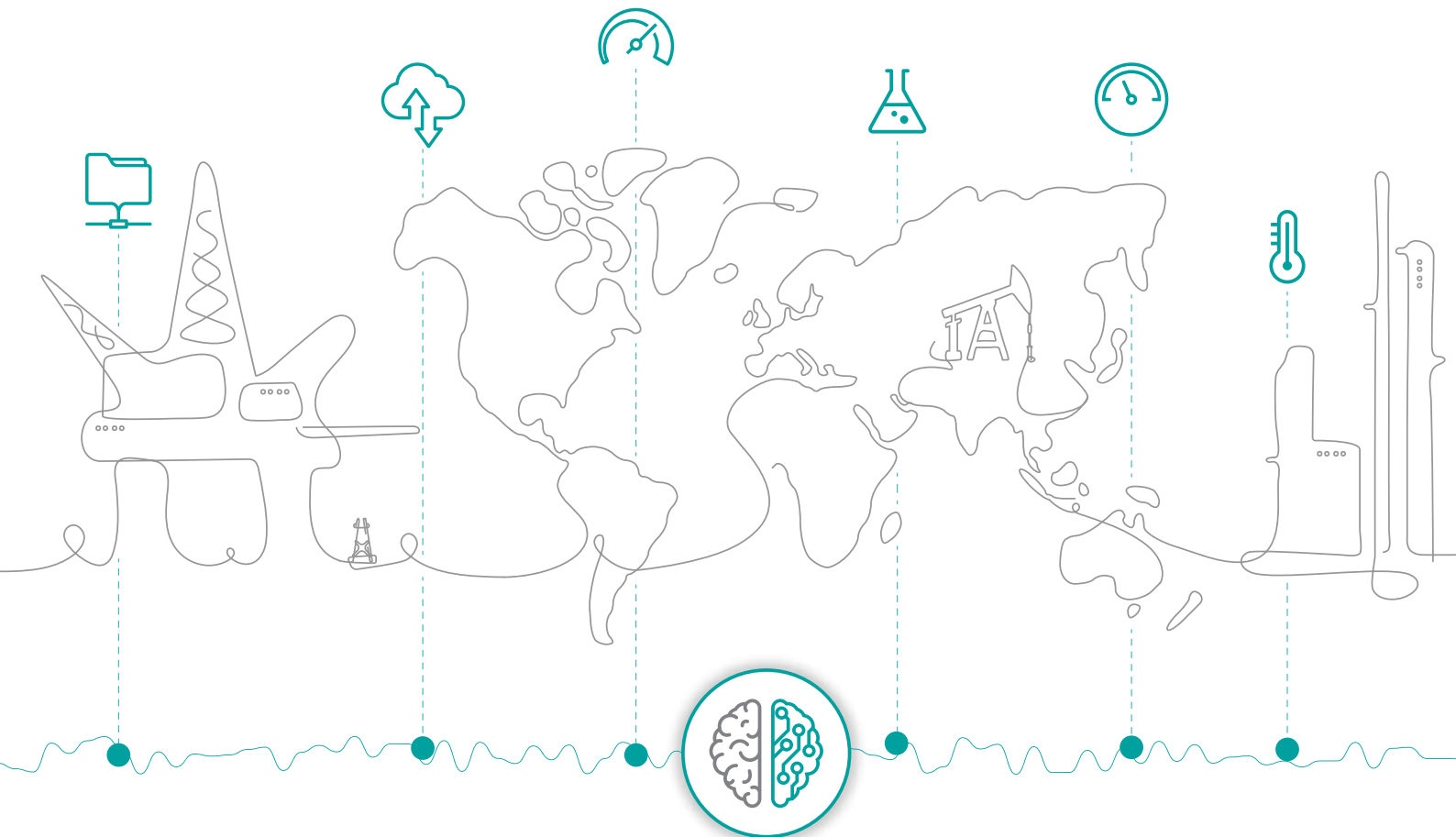
Some oil and gas companies are already seeing results from cognitive system projects, providing useful clues and approaches for others to follow.

This is a story about timely action. Specifically, it's about the evolution of technology from passive measuring devices to cognitively enabled systems that understand, reason and learn to support action with confident recommendations.

Ever since man began drilling for oil over 150 years ago, he has faced the same challenges: to get to the oil quickly, to drill safely and to maximise returns. Over time, technology has helped with these challenges, primarily through sensors. With the arrival of the Internet, these sensors (or 'things') needed an IP address to identify them, which in turn created the Internet of Things (IoT) and a huge amount of data.

Today, this data has grown in volume, variety and velocity. We have now reached a point where the data produced is beyond the capabilities to act quickly enough on the insights buried within it. But there is a solution: cognitive systems.

"Any given plant could have up to one million sensors measuring
continuously – creating monstrous amounts of data"
– IBM oil and gas SME

Timing is everything

Oil and gas takes between tens of millions and hundreds of
millions of years to form naturally. Yet the business of lifting,
transporting and refining that resource operates on a global
scale and on a near-real-time basis. It is a race against time to
ensure that expensive assets are being used in the right place at
the right time, delivering the right product mix. Downtime is
measured in millions of dollars, with moment-by-moment
decisions impacting across a hugely complex value chain.

Timely action drives efficiency and safety – two key outcomes
in oil and gas. Efficiency supports decision-making, greater
asset utilisation, business longevity and profitability, whilst
guarding against oil-price fluctuation, downtime and human
intervention. Safer operation means reductions in human risk,
environmental incidents and damage to business reputation.

Connected sensors, which are the basis of IoT in the oil and gas
sector, are key to supporting timely action. The oil and gas
industry, with its heavy investment in assets and the hazardous
nature of its operations, has long invested in sensors. Technology
has reached a point where the sheer volume of data being
created makes spotting patterns a complex undertaking.

Even after those patterns have been found, the task of turning
them into actionable insight, at the right time, remains elusive.
And all the while, the data keeps growing.

It's estimated that oilfield sensors generate petabytes of
production data,[1] though oil and gas companies typically use
only 1% of the data they generate.[2]

IoT past and present

With its asset intensity, the oil and gas industry has been at the forefront of connected devices long before IoT usage emerged in other industries. Measurement, monitoring and control have all been key industry features since the 1950s, which were followed by a wave of advanced process control in the 1980s.

Operations are carried out in remote and inaccessible parts of the world where communications are limited. Previously, if you wanted sensor data from a well, you would send someone out in a truck to read the instrument panel. Over time, sensors and communications became cheaper and more pervasive. More recently, as IoT technology has replaced older sensors, it hasn't been necessary to send field operators out to read instrument panels.
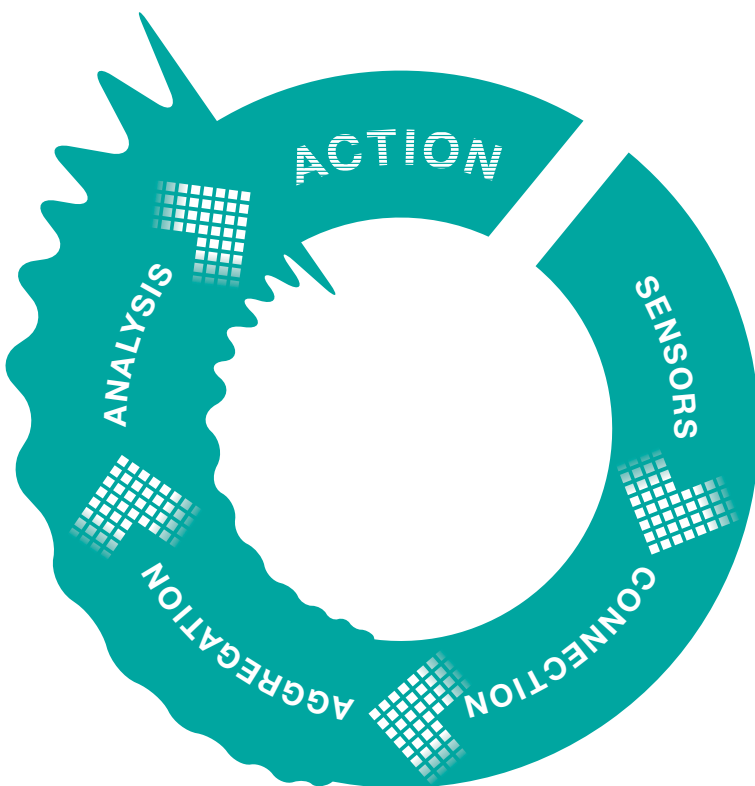
IoT soon began to add value, supporting the industry to make the crucial interventions, helping to avoid costly downtime. However, since devices have become cheaper, with more IP addresses to identify them, the volume of data has increased. This leaves huge data lakes untapped.

"IoT is just collecting data. The value comes when data is used for decision making." – Johan Krebbers, IT CTO & VP TaCIT Architecture, Shell International B.V.

Complications arise, for example, when data is drawn from an offshore drilling platform (measured in terabytes per platform). The low communications bandwidth from that platform alone can become a bottleneck for data delivery and analysis.

Furthermore, IoT devices only create structured data. This overlooks the considerable merits of unstructured data, examples of which include: weather reports, drilling reports, free-format text on maintenance records, mobile phone and email conversations, syndicated data, professional papers, social media and video.

With such vast quantities of data available, the value potential from IoT capabilities will grow significantly if insight can be rendered from the sea of data.

■ ■ ■ ■ ■ Structured data

Internet of Things Value Chain

Deriving new value: IoT + Cognitive = IoT^C

Cognitive computing is poised to transform organisations and industries. For the oil and gas industry in particular, the timing could not be better. To improve productivity and agility, the oil and gas industry must address energy-price collapse, reserves replenishment and extraction, rising resource development costs, and new safety and environment responsibilities.

But what do we mean by cognitive computing? In essence, cognitive systems are a new technology that applies human-like capabilities of understanding, reasoning and learning on data, unlocking new value by quickly addressing seemingly unsolvable problems.

"Traditional analytics reveals patterns. Cognitive systems create recommendations." – IBM oil and gas SME

Cognitive systems can process huge volumes of structured and unstructured data to understand and interpret relationships. Once established, cognitive systems can deliver recommendations, often close to real time. Such tasks would take even the most experienced worker years to achieve. Buying time in this way reduces risk and increases efficiency, which in turn cuts costs and boosts profits.

The 'great crew change' is underway, with one estimate reporting that over 350,000 jobs have gone since oil prices slumped in 2014[3]

Cognitive technology can respond to risks inherent in the 'great crew change'. These systems can draw on previous knowledge, making years of expertise available to the next generation of workers in an immediately actionable way.

For example, cognitive systems can monitor all the drilling sensor data in real time, comparing it with previous drilling reports and geological data. The technology can identify the potential for a stuck drill-bit with confidence, and with enough time to take preventative action. This ability to predict and act has huge financial implications – avoiding downtime cost for an offshore rig could save as much as $1,000,000 per day.

"Cognitive IoT is a way of using machine-learning approaches to analyse and learn from data from a multitude of sources. It is the harvesting of sensor data to improve outcomes and the additional benefits from cognitive are huge."
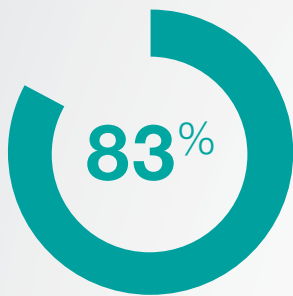– IBM oil and gas SME

CASE STUDY:
Woodside

Woodside, an Australian oil and gas producer, wanted to access knowledge from three decades' worth of projects in an attempt to save the company millions of dollars in efficiency savings. With IBM Watson, they created a service that culls through 30 years of documented expertise (in excess of 28,000 documents each with over 100 pages; the equivalent of a human reading 24 hours a day for 5.3 years), recognizing patterns and continually learning from them. Watson acts as a trusted advisor answering questions from engineers, while learning through newly adapted knowledge. With Watson, employees ask questions about prior projects in natural language and receive answers within seconds. With so much content available, users quickly target documents using filters such as project name or year. Watson learns how to provide better answers based on feedback from users. Woodside is able to save time, drive efficiency and reduce costs.
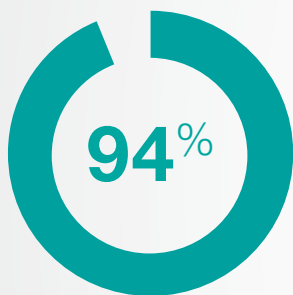
"We have a big bank of knowledge from over 30 years of operations; all that engineering expertise sits internally within the company, and is almost like a latent asset that we need to bring to the forefront."
– Shaun Gregory, Sr. VP Strategy, Science and Technology, Woodside
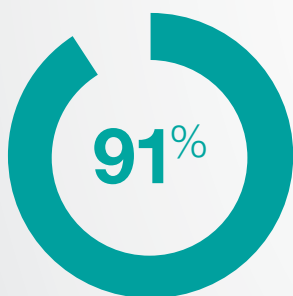
Watch the video case study

Improving the data flow

ACTION

ANALYSIS

SENSORS

AGGREGATION

CONNECTION

● ▲ ■ ★ ◆ Unstructured data

■ ■ ■ ■ ■ Structured data

Cognitive computing is an essential in oil and gas

83% ... of oil and gas executives familiar with cognitive computing believe that it will have a critical impact on the future of their business
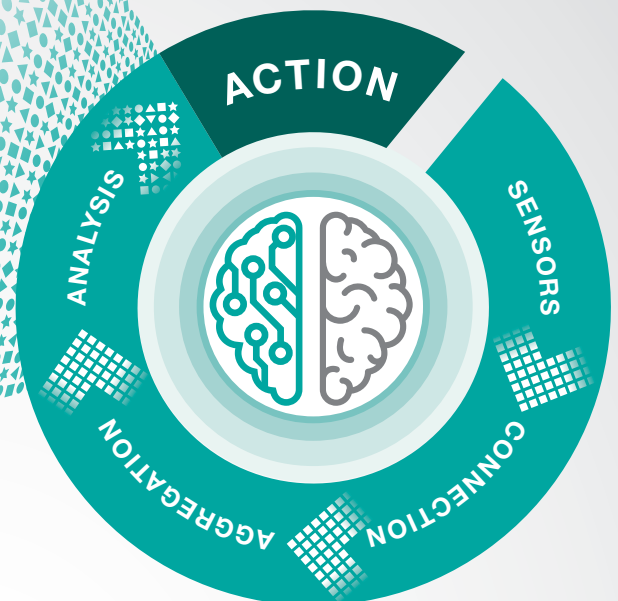
94% ... of oil and gas executives familiar with cognitive computing believe that it will play a disruptive role in the oil and gas industry

91% ... of oil and gas executives familiar with cognitive computing are likely to invest in cognitive in future

Source: 'A new natural resource: Your cognitive future in the oil and gas industry', IBM Institute for Business Value 2016

Improving the data flow

When companies inject unstructured data and add cognitive capabilities to the IoT value cycle, the actions available can have considerably more impact.

IDC COMMENTARY:

IBM – serving the oil and gas industry for over 50 years

In a recent report, analyst IDC commented that "in cognitive computing, IBM is helping large oil and gas clients make critical business decisions in several areas such as optimization of oil production and acquisitions of oilfields and prospect valuations and discovering the best ways to improve HSSE response and effectiveness. IDC Energy Insights believes that Watson and Cognitive will make a big difference for IBM in the next couple of years.

IBM has been serving the oil and gas industry for over 50 years, including more than 500 oil and gas companies worldwide, with 100+ of these clients engaged on an annuity cycle. Cognitive computing, predictive modelling, and personalized insights are the key areas the company has introduced to oil and gas clients over the past couple of years. IBM Watson – both its own set of APIs and its new IoT platform – and Bluemix cloud solutions act as PaaS offerings with 50+ services. IBM is positioned as a Leader in this IDC MarketScape for oil and gas professional services."

IDC MarketScape: Worldwide Oil and Gas Professional Services 2016 Vendor Assessment, Chris Niven, August 2016, IDC #US40842116

Harnessing IoT to the power of C
With the addition of cognitive capabilities, the full potential of IoT can be realised. This has been successfully achieved across a number of client projects.

Predict incidents
One company saved $250 million a year in downtime losses by using a cognitive system to combine drill-sensor data and unstructured data to predict stuck drill-bit incidents. Prediction confidence: 34–74% within a 3-hour window

Enhance maintenance operations
Cognitive systems can recognise a failing asset and demonstrate the 'next best action' to engineers via augmented reality devices. These devices can provide all the information stored on that asset from all sources (e.g. spec sheet, last service state, work order history, current condition, next scheduled maintenance).

Mitigate weather risks
Companies operating in arctic conditions are successfully using weather patterns, sea-ice flow, aircraft, satellite, radar, drone and historical data to predict the optimum times to drill. In one example an emergency management centre used weather data to safely guide staff around fumes driven by high winds.

Analyse proactively
Rather than relying on operators to take action whenever sensors trigger threshold alarms, companies using predictive analytics can spot anomalies in the data flow before thresholds are reached. Cognitive computing can take this further by learning new behaviours and trends.

Draw on experience
By applying data from a previously resolved incident, new engineers, using a data corpus of experienced engineer information, are able to solve new problems such as deterring birds from oil platforms.

Recognise similarities
A cognitive system helped to identify commonalities in reservoirs in extraction and production, based on similar examples, helping to make a timely, informed decision, which in turn supported a successful licence-agreement bid.

Generating a return on your IoT investment

There are clearly many situations where cognitive systems can create improvements in the oil and gas value chain. Given the industry's huge operational costs and the globally dispersed asset base, it's a sound investment.

IBM SMEs predict that cognitive IoT will have the greatest impact in the following areas:

	Upstream	Midstream	Downstream
Operational Efficiency	$$$	$$	$$$
Anticipating Risk	$$$	$$	$
New Revenue	$	$	$$

As you might expect, the drive for operational efficiency is paramount. However, the prospect of new revenue sources is also attractive.

The following questions from the IBM Institute for Business Value may help you consider a business case for a cognitive investment:

- Despite industry strengths in analysing and using numeric data, what other data (including unstructured elements) am I not leveraging? If converted to knowledge, how could I better meet key objectives and requirements?

- What is the associated cost to my organisation and the wider ecosystem of not having the full array of possible options to consider when decisions and actions are being made?

- What benefit could I gain from detecting patterns locked away in unstructured data by combining it with structured elements? How would this accelerate innovation, production or performance?

- What would change if I could equip every employee to be as effective as the leading expert in that position or field?

What does the future hold?

We asked our SMEs to comment on how they thought cognitive IoT would impact on operations. The dominant theme was unmanned operations with drones monitoring pipelines, leading to greater automation, quality and operational efficiency, with less human and financial risk. Others suggested that cognitive systems, utilising augmented and virtual reality, would become the norm, providing previously unimaginable insights and enhanced decision-making.

"Refineries and the largest assets will be linked via a cognitive IoT 'master program' able to run them remotely. You just need to specify what ROI you want!" – IBM oil and gas SME

"What 100 people do today could potentially be done more efficiently with the assistance of a cognitive system in the future. The quality of work would also significantly increase by leveraging cognitive IoT." – IBM oil and gas SME

"In 10 years' time cognitive systems will make the industry more automated, more confident and faster." – IBM oil and gas SME

"The goal is to increase the recovery factor from 30% to 35% with the same costs structure." – IBM oil and gas SME

"Cognitive systems will act as a continuous learning advisor: people that are working in the oil and gas industry will interact with cognitive solutions, and they will take advantage of the entire knowledge that was captured from different sources – such as industry reports, company reports, history, smartphone and email data, disasters, analogue data, weather data." – IBM oil and gas SME

"Blockchain could add value to the IoT, bringing traceability and accountability across the complex supply chain in oil and gas" – IBM oil and gas SME

Getting your operations in order

Before developing cognitive capabilities, some businesses may first have to improve their operational capabilities. Based on our interviews, clients stress the need to build their cloud, security and mobile infrastructure in order to understand how the integration of data supports predictive analytics. Effective use of data is a key component of an IoT platform. IoT sets the foundation of a data management platform and opens the door for cognitive.

There is no doubt that IoT has created considerable operational value for oil and gas companies. However, the industry has become overloaded with a vast volume of data, drawn from millions of sensors. Simultaneously, the demand for operational efficiency has grown against a backdrop of lower oil prices.

Cognitive systems have the ability to understand both structured and unstructured data in order to make the kind of timely, complex decisions that add value.

Additionally, with more and more experienced employees leaving the industry, the need to capture and transfer their expertise for the next wave of employees has never been greater. The volatile oil market is not just an opportunity to tighten operational efficiency: it's an opportunity for the industry to revitalise itself. Companies who seek to operate in a more agile, data-driven world can differentiate and become more competitive.

We believe that cognitive systems will help companies realise the full potential of IoT by delivering deeper insights in a more timely way than ever before. The capacity of such systems to understand, reason, learn and make prescriptive recommendations will help the industry 'buy time' – a commodity more valuable than oil itself.

Through buying time, companies can improve operational efficiency while being good stewards of the environment. It will be the industry's forward thinkers who will harness this power to shape their companies' future.

About the authors

David Womack is Global Director of Strategy and Business Development for IBM Chemical and Petroleum industries. He is responsible for identifying new market opportunities and leading alliances with key partners. He is an author of several industry studies and research projects, and is a speaker at industry conferences. Prior to IBM he was the COO of a management consultancy in the downstream, chemicals and power generation industry, and started his career with Exxon. David can be contacted on LinkedIn and at dmwomack@us.ibm.com

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