Fangda Qiu, Schlumberger, USA, Zaki Ali, Schlumberger, Kuwait, and A. Al-Jasmi, KOC, Kuwait, examine the concept of the ‘digital oilfield’ and look at the Kuwait Intelligent Digital Field (KwIDF) project as an example.
The digital oilfield is not a new concept, and has been known by many names over the last 20 years. Originally the term was often used in a fairly narrow context; referring to software and/or hardware employed to perform or automate a particular exploration and production task. It is only more recently that the genuine possibility of a much broader and comprehensive concept has emerged.

The digital oilfield concept has evolved, alongside key enabling technology, over the last 40 years from simplistic data gathering activities to online analysis, real time optimisation and automated workflow efficiencies – all significantly impacting an operator’s bottom line. The modern digital oilfield, however, is an expression of the link between people, processes and technology. With operators working in increasingly remote, unconventional, and challenging environments, collaboration between the office and the field must be properly integrated to enable optimal decisions to be made on live data. Powerful 3D modelling and visualisation systems are updated with new information as it becomes available to keep plans current. Data volumes have also increased greatly, bringing technical management and administration challenges.
The modern digital oilfield concept evolved alongside the technology that makes it possible. A number of key developments can be observed in this respect, starting with the first logging data transmission via satellite, in 1968. Five years later the first permanent pressure and temperature (P/T) gauge was installed, and the 1980s saw quartz crystal permanent downhole P/T gauge fitted to a subsea well. In 1989 the first transmission of onshore downhole gauge data was made to the surface, and in 1994 online gas optimisation was introduced. Continuing the online theme, on demand data delivery was made possible in 1999, and two years later it was possible to monitor electric submersible pumps over the web. The new millennium saw further developments, including remote cementing first undertaken in Norway in 2003, and real-time fracturing control introduced in 2006.

Many of these historical developments have been related to surveillance technology advancements. More recently, measurement technologies such as multiphase flow meters and high pressure, high temperature (HPHT) gauges and sensors have been introduced, making the modern digital oilfield truly possible. As a result, the industry has converged in the last decade on a common digital oilfield definition: enhanced asset management supported by a modern decision-making system designed to increase reserves, optimise reservoir drainage, improve production and operations and lower costs and capital expenditure. This is made possible through an open working environment: real-time, episodic and other data.

## Digital decisions

The modern digital oilfield uses real-time operations data from the field in a continuous cycle of production analysis, optimisation and detailed reservoir management. SCADA or distributed control systems (DCS) acquire diverse operational data from permanent subsurface well instrumentation, flowline network sensors and surface facilities; as well as manage field actuator equipment such as control valves. This capability supports real-time operation control and shutdown in an immediate (minutes to once-per-day) timescale. Beyond that, field data can be integrated into production management software over the medium term to allow accurate and ongoing evaluation, analysis and optimisation to take place. Over longer timescales of months to years, assets integrate field data to construct, calibrate and run numerical subsurface simulators and economics to plan the best field development scenarios.

This digital configuration allows operators to make key decisions centrally, across a number of assets. In the shorter term this can include topside process equipment control, rotating equipment monitoring and safety considerations. Medium term production decisions include well pressure drawdown to balance sand control and unwanted fluid breakthrough, production testing and well-rate estimation, and production optimisation through the ideal distribution of lifting gas. Longer term considerations include in-fill well planning, and defining the reservoir depletion strategy. Figure 1 shows a conceptual model of how such a digital oilfield decision system can be supported.

In Figure 1, level zero represents data gathering and transmission resources, including field measurement instrumentation and smart control equipment.

Level one is the surveillance level. Here potential production and reservoir drainage problems are detected using real-time feeds and
characterised by cross-disciplinary collaboration for the producing asset, it is an approach that leverages technology to streamline the interaction of people and processes. Typically, the fundamental objective is to improve operational effectiveness and maximise or optimise production for the life of the asset. This is achieved by taking objective decisions and improve the reservoir and production system.

**Integrated operations**

Integrated operations, in a modern digital oilfield context, refer to processes and methods of exploration and production, facilitated and connected by information and communication technology. Characterised by cross-disciplinary collaboration for the producing asset, it is an approach that leverages technology to streamline the interaction of people and processes. Typically, the fundamental objective is to improve operational effectiveness and maximise or optimise production for the life of the asset. This is achieved by taking the right decisions at the right time, using a holistic, asset-wide, cross-discipline collaboration.

KOC wanted a digital solution to increase production and recovery rates, while helping to keep costs down and maintaining safety and reliability. The company was also keen to reduce shutdowns, and any possible solutions. The third level is optimisation. It is here that alternatives are assessed, based on all possible data, technical constraints, risks and economics to inform strategic optimisation decisions and improve the reservoir and production system.

KOC digital oilfield production management workflows.

![Image](https://via.placeholder.com/150)

**Case study: Kuwait Intelligent Digital Field**

An example of how the digital oilfield concept has been applied to a modern unconventional production project can be witnessed in the Kuwait Intelligent Digital Field (KwIDF). The integrated cross-domain project was launched to bring together field instrumentation, automated workflows and multidisciplinary collaboration.

Kuwait Oil Company (KOC), the operator, was facing a challenging asset environment in one of its greenfield development projects in the form of a heterogeneous carbonate reservoir. Production optimisation. The ability to use a common platform for data management, modelling, simulation and production management activities greatly improves multidisciplinary collaboration.

**Digital KPIs**

The results of these new workflows, including key performance indicators (KPIs), are accessible to KOC users via a web portal surveillance solution for monitoring production at a glance. KPIs were introduced as part of the system implementation to provide specific, reliable and accurate information, tied directly to strategic production and business goals. KPIs are central to the project, since they indicate production progress and performance. Before each KPI was defined, the methodology of its measurement was carefully documented.
and agreed. An important part of this process was managing the required changes to everyday working practises for KOC management and field operators. The Schlumberger team worked alongside KOC senior management to change the corporate culture from the top down, introducing new collaboration methods. Software training was also provided to introduce the new system to users and demonstrate the improvements to everyday operations. This proved particularly helpful in ensuring employees were more comfortable and able to adapt to the new digital solution.

The new digital solution allows KOC to better manage its knowledge base of technical data and collaborative insights. The project team benefits from improved decision making as a result, with faster access to production data, which is now more accurate and customisable through the visual integration of datasets in management display screens.

KOC’s new integrated framework provides production data and operational workflows spanning the field to the main office. It has enabled validation of high- and low-frequency data for all production optimisation workflows and models, transforming field measurements into defined performance metrics. Intelligent digital field technology, combined with industry best practices means KOC is better positioned to minimise costs, utilise scarce resources and more effectively gather, manage and analyse essential field data. In addition, multidisciplinary collaboration has improved through the introduction of a common workflow platform and interface, streamlining operating processes. Widespread standardisation of common asset team procedures has delivered further efficiencies.

Productivity also increased due to the automation of routine tasks. Potential production issues can be proactively identified and visualised through the analysis of relevant data in context. Real time data feeds are combined with other sources for a consolidated view of any asset performance. Extensive new capabilities include early event detection, daily reporting, trending, data diagnostics, predictive modelling and a calculation engine.

The project also delivered a number of safety benefits. Potential equipment hazards can now be immediately identified, chokes are remotely operated and controlled, and a remote monitoring and shutdown capability enables well closure and isolation to be undertaken from a safe location.

Digital resistance and the future

The future of the digital oilfield is clearly linked to developments in related software and hardware - part of a wider theme to be discussed at the 2014 SIS Global Forum, held in Barcelona on April 15 - 17. This biennial industry conference will focus on the future of digitally mitigating E&P risk, using simulation and software technology.

As well as managing the technological aspect of the move towards a universally digital approach, an equal challenge is present in a conservative attitude to such change which, according to a 2012 BP poll, is widespread in the industry - 60% of respondents believed that resistance to change represented the biggest obstacle to realising the digital oilfield’s full potential.

It seems this resistance is gradually being overcome, however - the digital oilfield technology market has steadily grown over the years, taking an estimated US$ 18.7 billion in revenues in 2011. This trend is set to continue with a compound annual growth rate of 4.8% expected until 2022, when the industry should be worth US$ 33.3 billion. This could be attributed to the increasing complexity and expense in exploration activity, forcing operators to consider upfront investments in technology to mitigate risk and realise longer-term efficiency and cost savings.

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