WHITE PAPER

Communicating in the Digital Oilfield

EXECUTIVE SUMMARY

Since 1980 world energy consumption has been increasing at more than 2% per annum. Over three quarters of global energy consumption is sourced from fossil fuels - oil, gas, and coal – with oil traditionally taking the lead at around 33% and coal not far behind. But while demand keeps rising, oil and gas producers face challenges in controlling costs, locating new, harder-to-reach sources, meeting increasingly-stringent regulatory and environmental guidelines, as well as developing and maintaining business in politically unstable countries.

Oil companies also face a volatile market, so they need to work smarter. By unifying their critical communications, they stand to gain:

- greater coverage,
- more efficient operations,
- increased end user productivity and safety,
- increased cost savings,
- enhanced interoperability,
- greater resiliency.

ABOUT THE AUTHOR

Now an independent consultant based in New Zealand, Dr Jan Noordhof was Principal Consultant for Tait, specializing in technical solutions for public safety, utilities, mining, and oil and gas sectors around the world. He has held a variety of senior commercial and engineering roles in both analog and digital radio. Dr Noordhof has worked in TETRA development, software engineering, systems programming, telecommunications and embedded system design, and has taught at a number of universities.

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FACING UP TO THE DIGITAL CHALLENGE

Oil and gas producers face challenges in controlling costs, locating new, harder-to-reach sources, meeting increasingly-stringent regulatory and environmental guidelines, as well as developing and maintaining business in politically unstable countries.

Oil companies also face a volatile market. For example, in June 2014 the price per barrel of Brent crude was USD$115. By October of the same year it had dropped to USD$85 and early 2015 saw it consistently below $60. So oil companies need to work smarter.

Of course, other industries face similar challenges: power utilities for example have already embraced the Smart Grid concept, using digital telecommunications technologies to improve productivity, control costs, increase reliability, security and worker safety. Now oil companies are investigating the concept of a Digital Oilfield, to integrate their business operations using advances in communications technology.

But no single technology can fully service this integration, when companies must consider cost, coverage, spectrum availability, bandwidth, latency, ease of deployment, and flexibility.

The solution lies in unifying multiple technologies: an integrated mix of different communications technologies, ranging from VSAT satellite, to WiMax or LTE broadband, to WiFi, cellular, and digital LMR, each with its own strengths and weaknesses. As a 2013 Arthur D Little report into Oil & Gas communications put it:

"… *although some potentially ground-breaking communication technologies are now emerging, substantial scope for incremental improvement in existing technologies still remains, allowing an operator a diverse array of technologies that could be applied. In fact, often more than one viable solution is available*."

"… ALTHOUGH SOME POTENTIALLY GROUND-BREAKING COMMUNICATION TECHNOLOGIES ARE NOW EMERGING, SUBSTANTIAL SCOPE FOR INCREMENTAL IMPROVEMENT IN EXISTING TECHNOLOGIES STILL REMAINS …"

To appreciate what this means, we can start with the three sectors in the value chain of the oil and gas industry, and the operations belonging to each:

- **Upstream**
  Includes exploration, development, and production operations around surveys of underground or underwater crude oil or natural gas field, drilling exploratory wells, and setting up capital projects to create onshore or offshore production facilities to bring the oil or gas to the surface. Upstream companies include Saudi Aramco, Gazprom, NIOC, and Petrobras.
- **Midstream**
  Focus on transport and storage, bringing oil and gas from wells to processing facilities through pipelines, tankers, LNG ships, trucks or rail, or to storage facilities at terminals. The output of midstream processing is feedstock. Midstream companies include Kinder Morgan Energy Partners, Plains All America Pipeline, and Enridge Inc.
- **Downstream**
  Concerns refining, marketing and distribution operations. Feedstock is refined or separated into saleable products (gasoline, jet fuel, diesel, kerosene, petrochemicals etc) and natural gas is processed and purified. The resulting products are marketed and distributed through distribution centers and retail sites such as gas station chains. Downstream companies include Exxon Mobil, Shell, Sinopec.

  Companies such as Chevron, BP, Petrobras, and Statoil incorporate all three sectors.

Exploration, field development, and production (E&P) are expensive and risky. They offer no guarantee of commercial success, and upstream companies are now forced to explore new fields in ever more remote and dangerous locations, or to squeeze more production volumes out of older fields. In 2015 capital expenditure by these companies is estimated to reach USD$500bn (of which over 10% is IT alone), at the same time experiencing a shortfall in skilled labor of 500,000 (over and above the current workforce of 3.5 million). require increasingly-scarce engineers and experienced technicians. Non-productive time, such as downtime due to rig failure, costs the industry over $26 billion each year.

THE DIGITAL OILFIELD AND THE INTERNET OF THINGS

The Digital Oilfield, (also called 'Integrated Operations', 'Smart Field', 'Intelligent Field'), refers to the convergence of IT, digital telecommunications, IP networking, and the idea of the Internet of Things to integrate, automate, and optimize upstream operations. The diagram illustrates the complexity required of modern communication systems, as numerous systems, applications and the technologies supporting them converge.

The Internet of Things involves physical devices communicating directly with each other - machine-to-machine - without human intervention. In the Digital Oilfield, smart elements such as sensors, measuring devices, and actuators embedded in drills or wellheads exchange data in real time, so they can be monitored, integrated, configured, optimized, and managed; even manage themselves. A wireless network connects these elements, and, utilizing purpose-built applications, sends their combined and integrated data to servers for storage, retrieval, processing and analysis.

… THIS APPROACH BRINGS, AS ONE REPORT PUT IT, "THE FIELD TO THE OPERATOR RATHER THAN THE OPERATOR TO THE FIELD."

Millions of smart elements can be sending real-time data 24/7, so datasets and data flow can be huge. Since a single rig can generate one terabyte of data each day, the total amount of data that passes through a Digital Oilfield can be potentially petabyte-sized (10^{15} bytes) or larger per day.

The Digital Oilfield manages the actual field digitally, largely automatically, and in some cases, fully remotely. In a control room, personnel see and interact with an accurate virtual representation of the field and all its components. Field data is processed continuously in real time, with applications automating decision-making, performing predictive analyses, reacting to alarms, and monitoring and controlling production process – with or without human intervention.

REMOTELY CONTROLLING OPERATIONS IN REAL TIME

The degree of real-time control that operators can exercise is remarkable. For example, with Remote Drilling, data such as bit RPMs, circulation solids, and downhole pressures are captured by a Measurement-While-Drilling (MWD) system, integrated, Logged-While-Drilling (LWD), and sent to an operator who can remotely steer the downhole tools. The result is more accurate drilling, optimized path and drilling processes in real time, and significantly less reliance on specialists and service personnel onsite in isolated locations. A 2003 study by Cambridge Energy Research Associates (CERA) estimates that this reduces drilling costs between five and 25 percent.

Other capabilities of the Digital Oilfield include:

- SCADA networks that directly manage facility process systems e.g. by controlling pumps and valves,
- real-time surveillance of production system performance and reservoirs,
- surface-controlled equipment that continuously monitors underground conditions and responds as required,
- visualizations and dynamic modelling of changes in a reservoir using 4D seismic data,
- collecting and analysing equipment status and performance to predict and respond to equipment faults before they occur, thus minimizing downtime,
- on-site field staff and offsite experts collaborating remotely to share information via voice, data, and real-time video, to improve the quality and speed of decision-making,
- managing historical data and workflow analyses to create standard ‘best company practice’ workflows for teams that monitor, operate, develop and maintain a field, freeing up engineers from this responsibility,
- standardized production data and production allocations for accurate forecasting and efficient real-time decision-making,
- integrating representations of the reservoir, production, injection network, wells, economics and planning tools, modelling the entire field so operators can optimize field production and run forecasts.

In short, this approach brings, as one report put it, “*the field to the operator rather than the operator to the field*.”

WHAT LIES AHEAD FOR THE DIGITAL OILFIELD

Estimates from the recent Digital Oilfields World Summit suggest that in 2015, the Digital Oilfield services market will have grown by 40% - to more than $3.18 billion. The bottom-line benefit of deploying these services is projected to be a 25% increase in the net present value to:

- reduce E&P costs and shorten schedules,
- raise productivity,
- slash downtime (which can cost up to several million US dollars per day),
- make better use of the shrinking pool of experienced technical staff,
- improve worker safety and health,
- extend the lifetime of ‘brown fields’ (which previously would have reached the end of their economic life),
- undertake more complex projects to access reserves in difficult environments.

THE VITAL ROLE OF TELECOMMUNICATIONS IN THE DIGITAL OILFIELD

Underlying any Digital Oilfield is an integrated communications system that is completely reliable, resilient, cost-effective, robust, and secure. Field telecommunications are critical to the success of Digital Oilfield services.

1. All devices in the Digital Oilfield must be physically robust including communications equipment. They must comply with UL/cUL C1D2, ATEX Zone 2, IECEx, DNV, and ABS hazardous and environmental standards. Industrial enhancements, like wide temperature tolerance, IP ratings from 30 to 68, sturdy metal cases, and conformal coating may also be necessary, based on the individual field environment.
2. Network design must guarantee high availability with end-to-end redundancy, since the efficiency consequences and economic cost of an outage is substantial.
3. Network architecture must be flexible to adapt to the differing requirements at each phase of an E&P project. For instance, mobility requirements will be highest for onshore exploration and high for offshore exploration, but diminish considerably during production.
4. Field backhaul and field access communications require a mixture of wired and wireless connections due to performance requirements, geographical location, cost etc.
5. The architecture must integrate the wide variety of technical requirements presented by each element – from drilling rigs to operation centers and enterprise systems.
6. The Digital Oilfield is built around big data management. The network may need very high bandwidth connections capable of transferring large datasets continuously. (The industry-standard Akamai definition of 'high broadband', is at least 5 Mbps. See the Akamai '*State of the Internet' 1st Quarter 2012 Report*).
7. For monitoring and control, the network may need to support connections with very low latency connections – that is, 35 milliseconds or less.

DYNAMIC COMMUNICATION ACROSS THE DIGITAL OILFIELD

It is not just oil or gas field exploration and extraction operations that stand to benefit from the real time communications network. The field activity associated with these operations can benefit significantly from dynamic communications networks.

- **Hydrocarbons delivery and quality:**
  for example, instrumentation, SCADA, project management and field automation.
- **Safety and security:**
  for example, emergency communications, go-ahead message broadcasts, access control, environment monitoring and video protection.
- **Operations and living:**
  for example, workforce management and collaboration, cyber security, infrastructure supervision, control center, and employee infotainment.

CONCLUSION

Field telecommunications are critical to the success of Digital Oilfield services. In the near future, extraction companies will be rethinking the plethora of single-function bearers and applications that many exploration and extraction companies currently operate.

Rather, the future for the Digital Oilfield is to deliver business efficiencies, by bringing the field to the operator rather than the operator to the field. Underlying any Digital Oilfield is an integrated communications system that is reliable, resilient, cost-effective, robust, and secure.

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