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# Eyes along the string optimize the Barents in real time

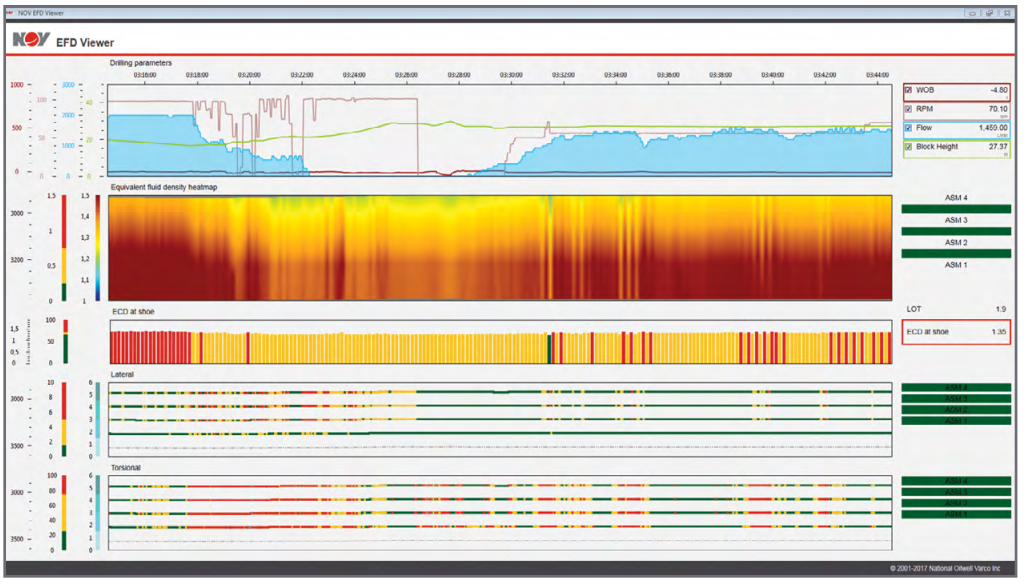
Sanna Zainoune and Stephen Forrester, of NOV, and Børge Nygård, of Statoil, discuss how wired drill pipe helped Statoil understand downhole conditions while drilling the Barents Sea exploration wells.

The persistent need to increase uptime, cut project costs, and improve drilling performance has driven implementation of more advanced technology in the oilfield. The relative stagnation of the current oil price and future pricing forecasts, which have stalled at around US$50/bbl, have made it clear that companies must research new ways of achieving profitability in this market.

As wells become more and more challenging, the amount of issues that can occur downhole continues to increase. This problem, compounded by both the technological complexity and high costs of deployed equipment and tools, means that it is now more important than ever that downhole conditions be analyzed and understood in real time. National Oilwell Varco (NOV) developed a suite of integrated downhole products and technologies, including BlackStream along-string measurement (ASM) and enhanced measurement system (EMS) tools, an equivalent fluid density (EFD) viewer, and IntelliServ wired drill pipe with a high-speed telemetry network, to enhance real-time understanding of borehole conditions in wells around the world. NOV partnered with Norwegian operator Statoil to use this product/technology suite in its Barents Sea exploration drilling campaign in 2017, with several key objectives:

- To prove that wired drill pipe is a viable technology.

**Above: *Songa Enabler.*** Photo from Songa Offshore.




**EFD Viewer.** Photo from NOV.

- To use accurate real-time downhole measurements for increased efficiency and safety in environment-sensitive wells.

- To implement wired drill pipe as future part of Statoil's digitalization and automated drilling strategy.

Statoil started the drilling campaign in the spring of 2017. The campaign involved a five-well project for the Blåmann, Kayak, Korpfjell, Gemini Nord, and Koigen Central prospects, which are expected to clarify viable opportunities for future drilling in the Barents Sea. The *Songa Enabler,* a floating, self-propelled, winterized rig designed specifically for use in cold climates, was chosen for the exploration campaign because it is one of the most technologically advanced rigs in the entire Statoil fleet. The rig has advanced automated drilling control system installed. Automated drilling, for Statoil, refers to a group of technologies that provide significant and remarkable benefits. High-speed telemetry is part of the group and regarded as an enabler for future drilling automation. NOV delivered a high-speed telemetry system consisting of:

- **Wired drill pipe and associated telemetry network**

The telemetry network enables instantaneous, bidirectional transmission of downhole data. Telemetry speeds reach up to 57,600 bits/sec versus the significantly slower rates achieved with current mud-pulse or electromagnetic telemetry methods, ensuring the downhole tools are connected in real time. To create wired drill pipe and enable this real-time data transmission, the double-shouldered connections of each tubular joint are embedded with a high-strength coaxial cable and low-loss inductive coils.

- **ASM and EMS tools**

ASM tools are compact, collar-based tools that can be placed along the drillstring to acquire downhole drilling dynamics and hydraulics measurements. Connection to the networked drillstring provides streaming visualization of downhole data for immediate analysis. EMS tools acquire high-frequency downhole data from positions in the bottomhole assembly (BHA) for analysis and optimization of drilling parameters, transmitting data to the surface in real time via the wired drill pipe network, with or without flow.

- **EFD viewer**

The EFD viewer was developed to display time, depth, and along-string measurements in a user-friendly way. It combines surface parameters, equivalent circulating density (ECD) in a heat map, interpolated ECD at the shoe, and vibrations. Measured depth is shown on vertical axis, while time is displayed on horizontal axis. Data is appended on right hand side before moving along screen. Diagnostics are also color-coded and make it easy to make decisions based on the continuous measurements.

Using the high-speed telemetry system enabled Statoil to achieve impressive operational and performance benefits. Wired drill pipe raised the rate of penetration (ROP) limit by removing constraints on data acquisition while still providing confidence that the hole was being cleaned while drilling. The telemetry significantly increased the quantity of streaming data for analysis and transmitted LWD-quality memory data in real time. The telemetry system achieved an average uptime of 98.2% over the five wells and four pilot holes, and Statoil only experienced eight hours of non-productive time (NPT) in total. The high-speed telemetry of the wired drill pipe network improved connection times by eliminating the need to pump up data, such as surveys or leak-off tests (LOTs). Weight-to-weight time was reduced by 23% due to the increased focus on efficiency during connections.

Real-time flow-off pressure readings from sensors distributed along the drillstring help monitor how the annulus gets loaded or unloaded with cuttings, depending on drilling parameters. While drilling the first riserless section, a sudden annular pressure increase was seen on the LWD sensor after the connection was made, and the pumps were immediately shut down to prevent a full packoff. The pressure increase was not indicated by the EMS tool placed right above the BHA, indicating that the cuttings accumulation was located between the LWD and EMS sensors. Distributed readings enabled the operator to follow the cuttings as they were circulated out of hole using low flow rate and RPM. EMS measurements helped in understanding the exact location of the tight hole conditions, with the packoff monitored up the annulus using both downhole torque and annular pressure.

Having knowledge of the packoff event allowed Statoil to optimize their sweep strategy. The along-string sensors were then used to monitor the sweep pills' position and manage pumps in an extremely accurate manner. The RPM measurements, noted as the curve separation between maximum and minimum RPM (stick-slip), from the ASM and EMS tools were also used to monitor the efficiency of the sweep pills.

Drilling vibrations are potentially very damaging and can cause early drill bit or BHA failure. The BlackStream sensors,

placed along the drill pipe, helped in understanding those vibrations in real time while drilling through some relatively hard formations. Downhole torque was used to ensure the bit was responding to changes in parameters, including RPM and weight on bit (WOB). Following some spikes in downhole torque, the PDC bit torque response changed and did not increase with higher WOB. Off-bottom stick-slip also appeared, indicating tight hole conditions, and erratic internal pressure readings were measured by the BlackStream tools while circulating off bottom. While the ECD was consistent with flow rates, internal pressure indicated that there was obstruction in the flow path. After pulling the bit to surface due to low rates of penetration, the bit was found under gauge, confirming the diagnostic indicated by the BlackStream measurements.

Statoil commented that, "for drilling operations, understanding downhole conditions is key. In addition to advanced modeling of downhole conditions, high-speed telemetry and wired drill pipe enable us to monitor downhole data in real time, which was not available before. Our goal for the future is to act upon real-time downhole data to improve drilling efficiency and to avoid problems related to downhole conditions. Also, high-speed telemetry will potentially improve placement of our wells in the reservoirs."

Integrated technology packages will continue to grow in importance as the industry searches for safer and more efficient ways of drilling in challenging frontiers, and operators such as Statoil, who are eager to implement digital solutions, will continue to drive future developments of more advanced products and technologies. OE

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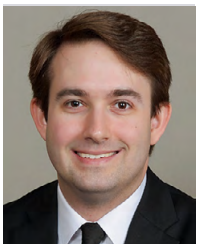

***Stephen Forrester*** *has worked at NOV as a marketing/technical communications writer since 2014. He researches and executes strategic marketing communications and technical writing opportunities to support the company's diverse businesses. Before joining NOV, Stephen worked for the oil and gas division of Lloyd's Register as a technical editor. Stephen holds both a BA and MA in English from the University of Houston.*

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