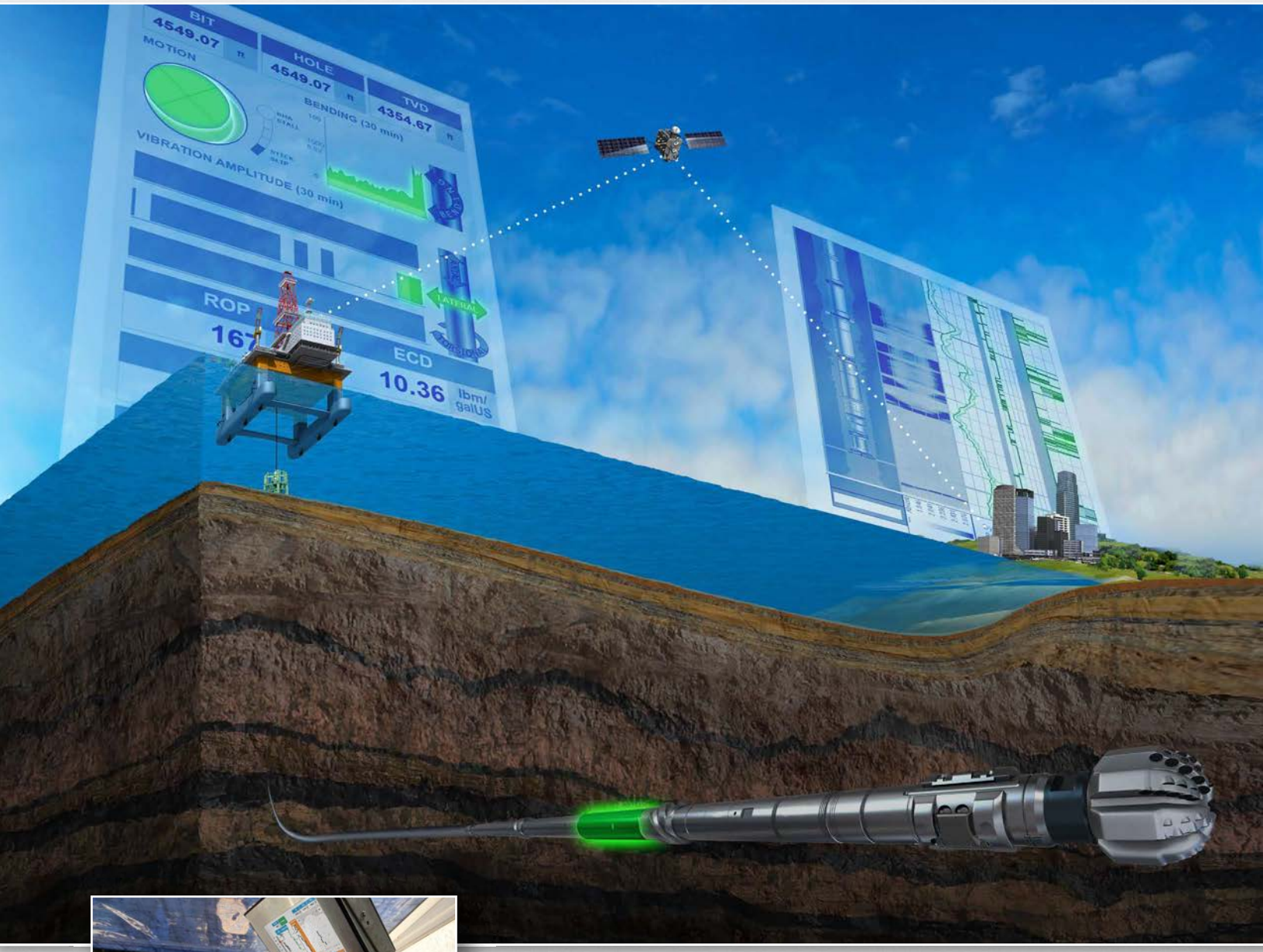
Schlumberger



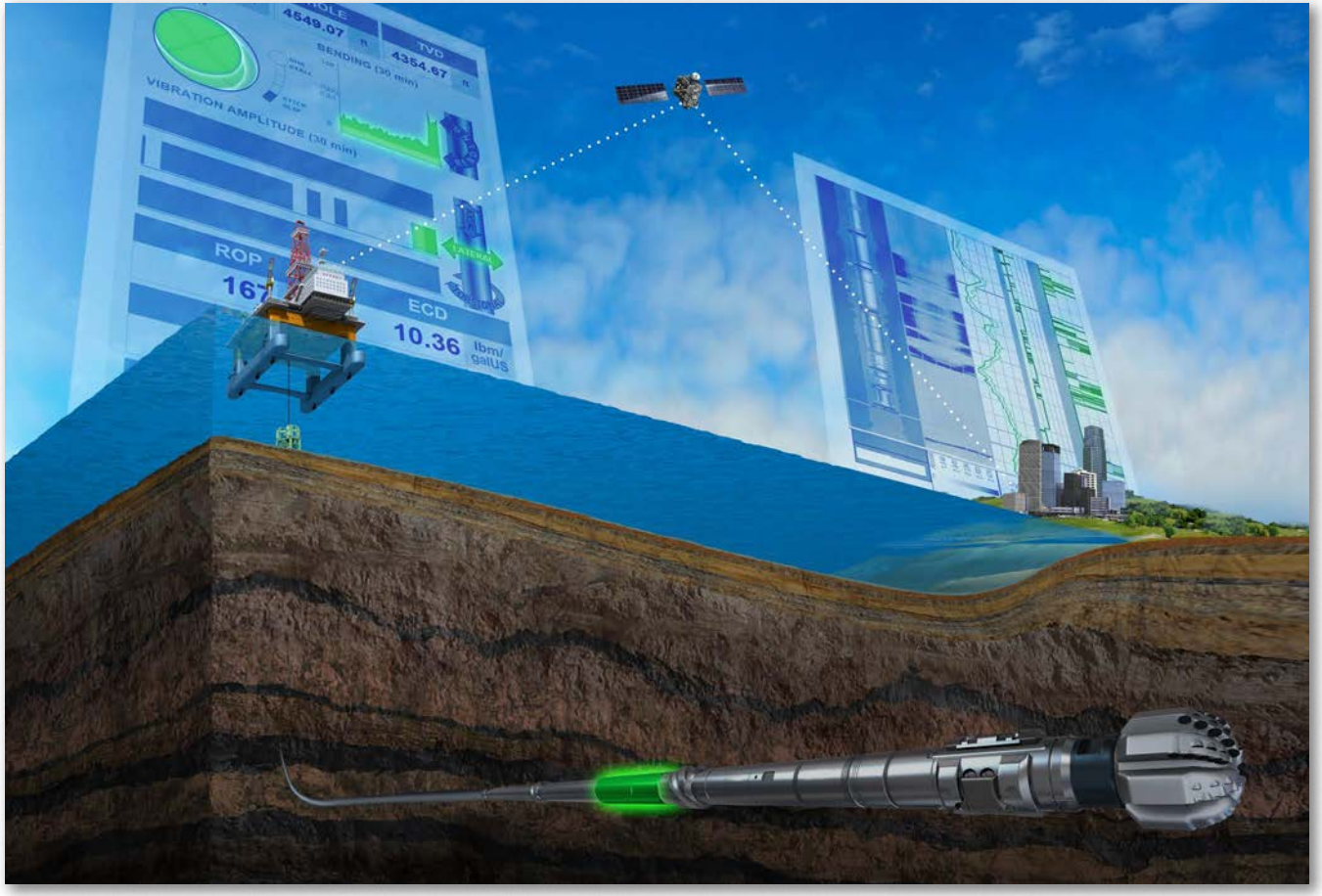
OptiDrill

Real-time drilling intelligence service

OptiDrill

Real-time drilling intelligence service

Manage downhole conditions and BHA dynamics with the OptiDrill* real-time drilling intelligence service. Integrated downhole and surface data provide actionable information on a rigsite display to mitigate risk and increase efficiency. These data are simultaneously interpreted by remote experts, who collaborate with the drilling team to improve performance.



Applications

- Risk mitigation
- Drilling performance improvement
- Wellbore quality enhancement

Benefits

- Reduce BHA failures
- Identify and mitigate poor hole cleaning and sticking pipe tendencies
- Improve ROP by maximizing drilling efficiency
- Extend bit runs by preserving cutting structures
- Manage borehole tortuosity to aid casing running
- Optimize BHA design and bit selection
- Evaluate drilling technology performance
- Validate and calibrate drilling models

Features

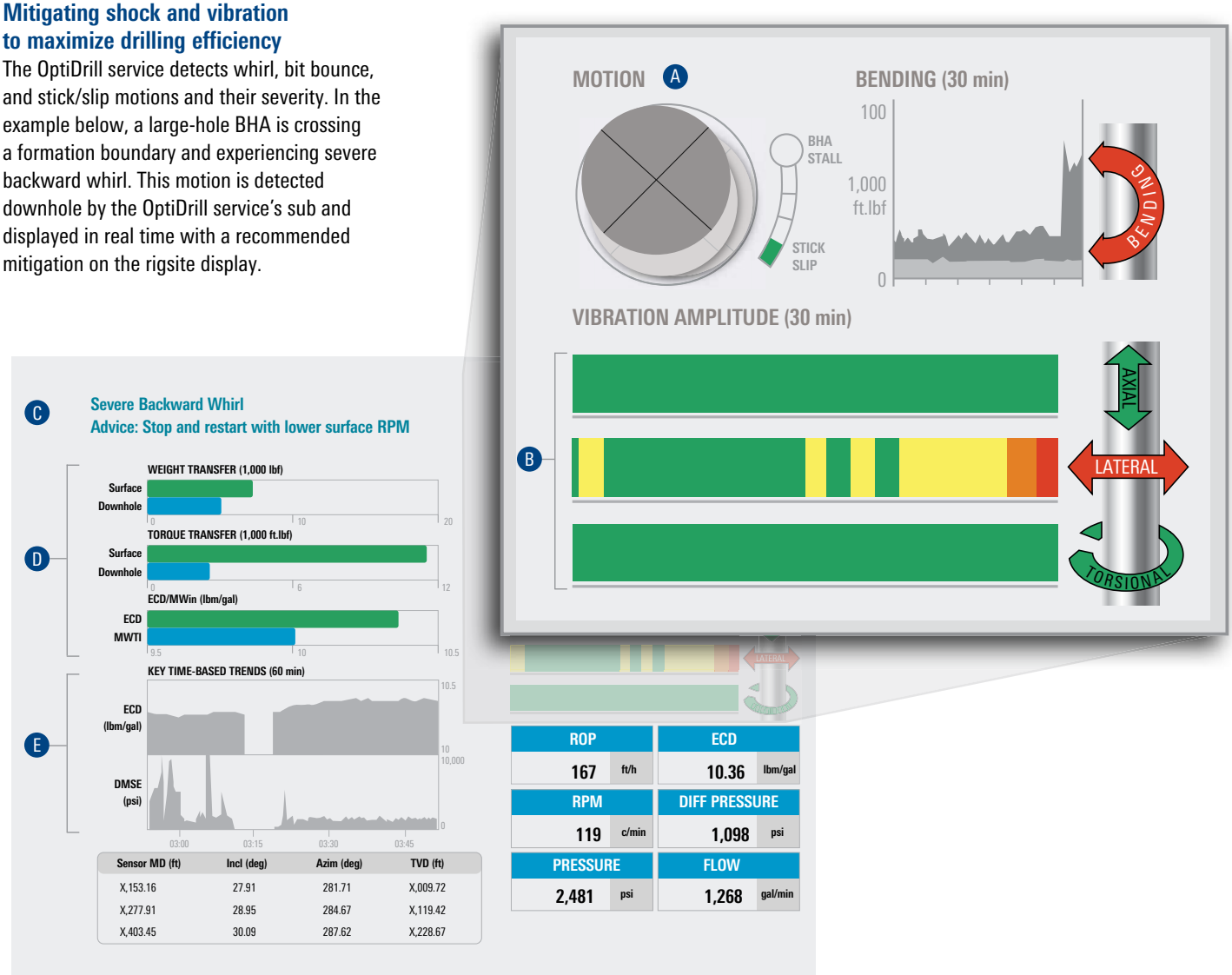
- Downhole sub with 19 drilling mechanics and dynamics sensors
- Real-time drilling answers, including
  - downhole detection of whirl, bit bounce, and stick/slip motions and severity
  - estimation of weight on reamer
  - continuous calculation of borehole friction factors
  - estimation of wellbore curvature from bending moment
  - plugged-nozzle and drillstring washout quick event detection
- Rigsite dashboard with integrated data display
- While-drilling monitoring, analysis, and recommendations from remote experts
- Continuous recording of low- and high-frequency data for postrun analysis

Quantify risk and manage downhole conditions

The OptiDrill service helps you mitigate risk and improve drilling performance through early detection of ROP limiters and drilling hazards. Real-time motion detection and weight-on-reamer information allow the rigsite team to proactively manage parameters. The OptiDrill service provides the driller with immediate guidance on how to mitigate severe downhole dynamics. Early intervention typically lessens the severity of an event, protecting the BHA and extending the length of the bit run.

Mitigating shock and vibration to maximize drilling efficiency

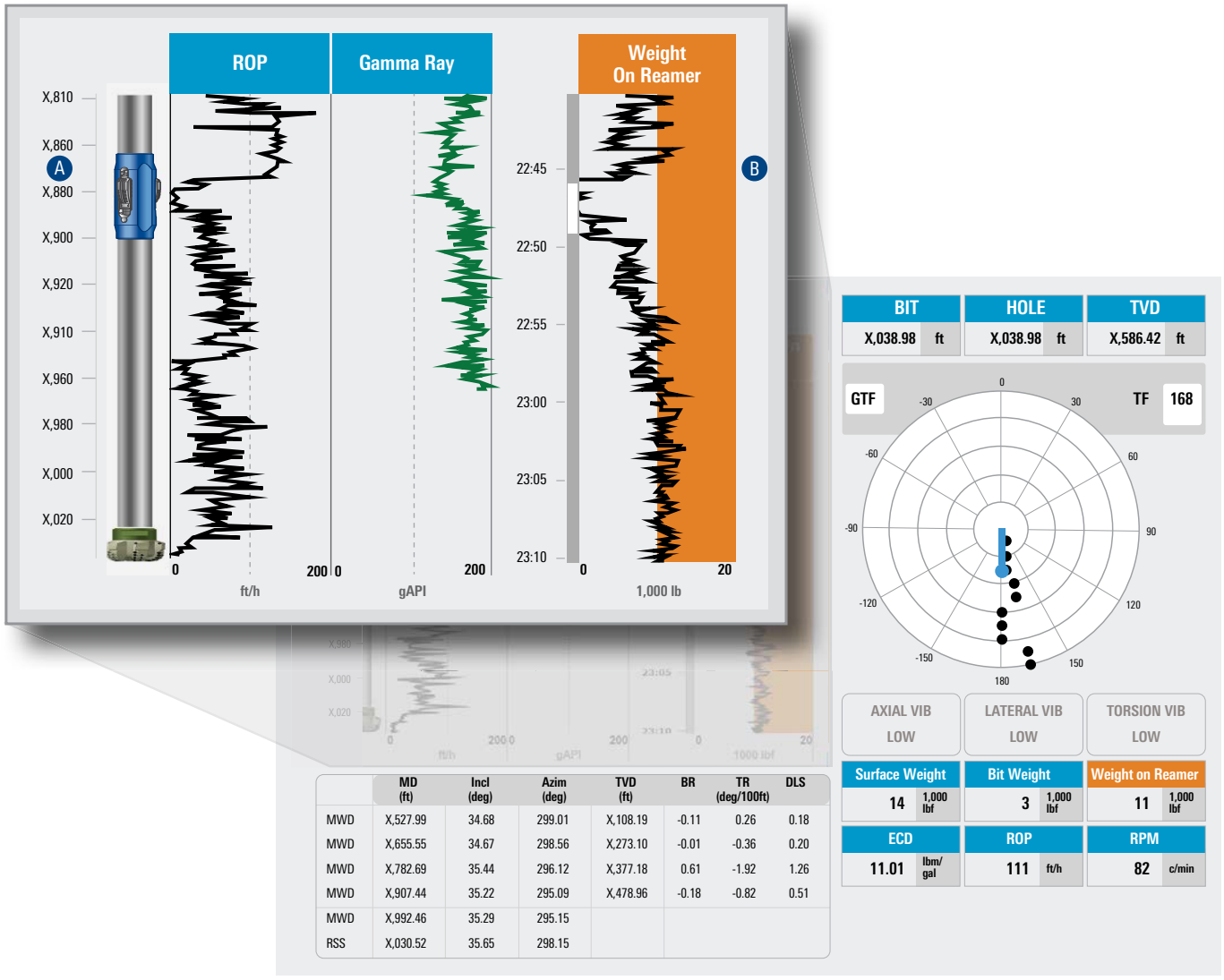
The OptiDrill service detects whirl, bit bounce, and stick/slip motions and their severity. In the example below, a large-hole BHA is crossing a formation boundary and experiencing severe backward whirl. This motion is detected downhole by the OptiDrill service's sub and displayed in real time with a recommended mitigation on the rigsite display.



- **A** Animation of downhole motions requiring immediate attention to preserve the life of the BHA
- **B** Progression of vibration type and amplitude to help modify drilling parameters and minimize energy lost to vibrations
- **C** Guidance to aid mitigation
- **D** Quantification of weight and torque transfer to enable early identification of abnormal downhole conditions
- **E** Calculation of equivalent circulation density (ECD) and downhole mechanical specific energy (DMSE) to understand hole cleaning and drilling efficiency trends

Managing drilling parameters to extend the life of the reamer

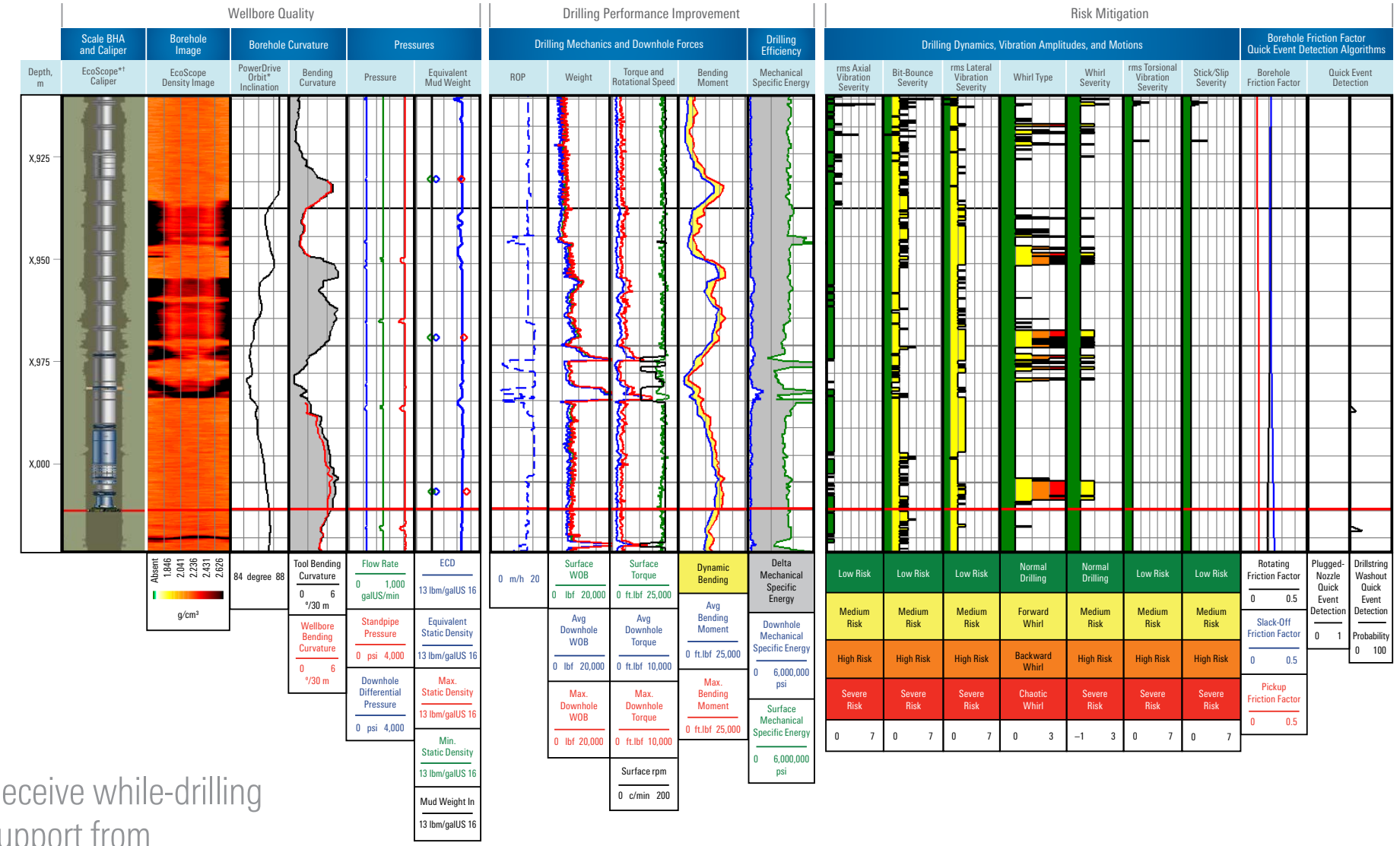
In reaming-while-drilling applications, the OptiDrill service continuously estimates weight on reamer by combining downhole measurements from below the reamer with surface measurements. In the example below, the BHA is passing through formations with significant strength contrasts. The driller is using the estimated weight on reamer and a visualization of the reamer location to proactively manage surface weight to keep the weight on reamer within an acceptable range.



	MD (ft)	Incl (deg)	Azim (deg)	TVD (ft)	BR	TR (deg/100ft)	DLS
MWD	X,527.99	34.68	299.01	X,108.19	-0.11	0.26	0.18
MWD	X,655.55	34.67	298.56	X,273.10	-0.01	-0.36	0.20
MWD	X,782.69	35.44	296.12	X,377.18	0.61	-1.92	1.26
MWD	X,907.44	35.22	295.09	X,478.96	-0.18	-0.82	0.51
MWD	X,992.46	35.29	295.15				
RSS	X,030.52	35.65	298.15				

A Visualization of the location of the reamer in the formation to help determine cause of change in weight on reamer

B Estimation of weight on reamer to increase the life of the reamer through proactive management of surface weight on bit and rpm



Receive while-drilling support from interpretation experts

Data from the OptiDrill service is transmitted to surface for use by the rigsite team and for interpretation by remote experts. The experts collaborate with the drilling team to reduce risk, improve drilling performance, and manage borehole quality.

Wellbore quality monitoring

To aid casing running, the service detects microdogleg and spiraling using bending moment data. Real-time wellbore quality data logs enable evaluation of the stability of the borehole over time.

Drilling performance improvement

In addition to the rigsite visualization of drilling efficiency information and immediate guidance for mitigating BHA dynamics, remote interpretations are shared with the rigsite team to help identify optimal surface parameters.

Risk mitigation

Automated quick event detection algorithms monitor for indications of plugged bit nozzles and drillstring washout.

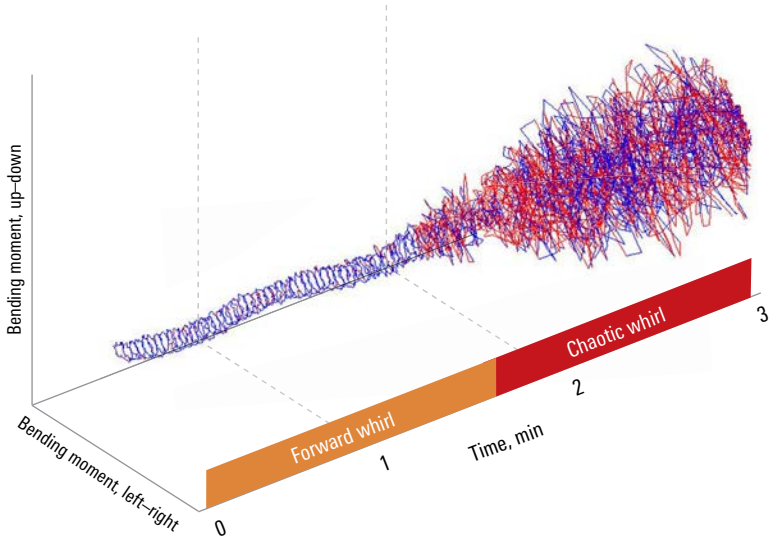
Using surface and downhole measurements, the OptiDrill service continuously calculates torque and drag to provide borehole friction factors for early identification of sticking pipe tendencies.

Improve future performance with postrun insight

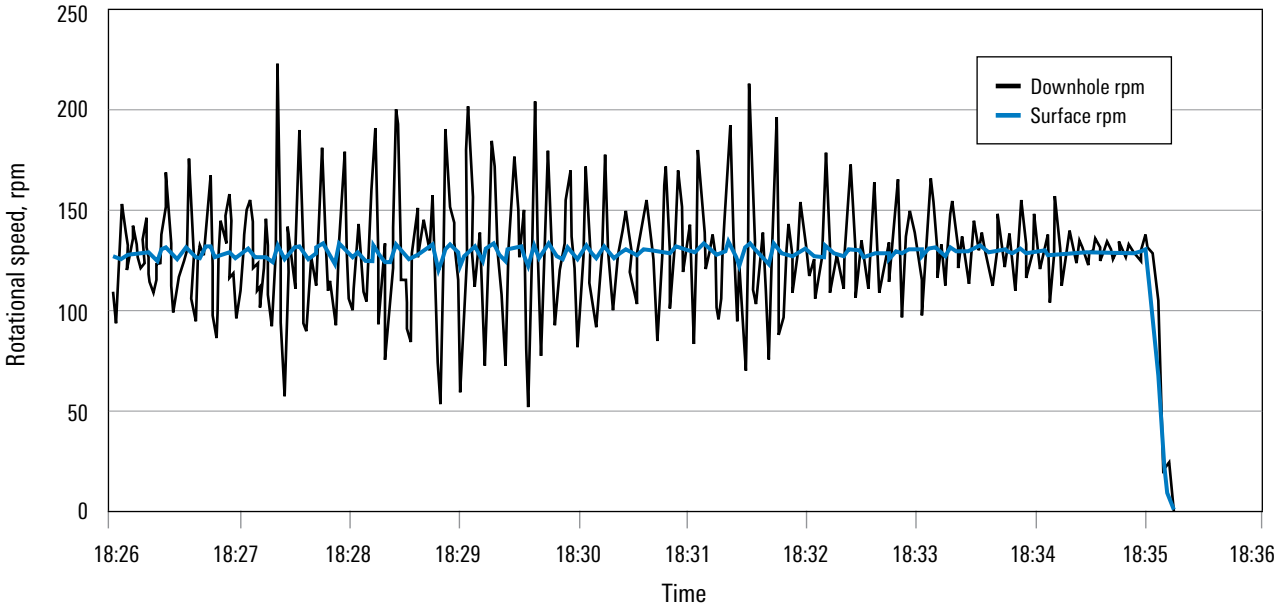
The OptiDrill service records low- and high-frequency data, which are available for postrun analysis to evaluate drilling system performance. This information provides valuable input for the planning of future wells.

Key applications of this recorded-mode information include

- validating and calibrating drilling models
- increasing knowledge of formation drillability
- optimizing BHA design and bit selection
- evaluating the performance of drilling technology.



A BHA with a reamer entered forward whirl motions and then chaotic whirl motions, which were detected and mitigated in real time. Postrun analysis revealed that the whirling motions occurred when the reamer entered an unstable formation. This information will be used while drilling future wells planned in this formation.



A postrun visualization of surface and downhole rpm was used to evaluate the effectiveness of a surface control system to minimize stick/slip. The chart was created using high-resolution (50-Hz) data recorded by the OptiDrill service.

Specifications

Mechanical	OptiDrill 675	OptiDrill 900
Nominal OD, in [cm]	6.89 [17.50]	9.18 [23.31]
Nominal ID, in [cm]	4.80 [12.19]	5.74 [14.57]
Max. OD (wearband), in [cm]	7.78 [19.76]	10.40 [26.41]
Length, ft [m]	9.84 [2.99]	11.54 [3.51]
Weight in air, lbm [kg]	903 [410]	2,151 [976]
Top thread connection	5½ FH box	7⅝ H90 box
Bottom thread connection	NC50 (4½ IF) box	7⅝ Reg box
Connection makeup torque, ft.lbf [N.m]	24,000 [32,539]	65,000 [88,128]
Connection yield torque, ft.lbf [N.m]	44,000 [59,655]	114,000 [154,563]
Mechanical Operations		
Max. temperature, degF [degC]	302 [150]	302 [150]
Max. shock (cycles), g_n	250	250
Operating flow range, galUS/min	0 to 800	0 to 1,600
Max. operating pressure, psi [MPa]	30,000 [206]	30,000 [206]
Max. differential pressure, psi [MPa]	5,000 [34]	5,000 [34]
Pressure drop coefficient (C)†	142,000	1,420,000
Max. dogleg severity, °/100 ft		
Rotating	8	6
Sliding	16	12
Max. overpull (tension), lbf	550,000	930,000
Max. weight on bit, lbf	$120{,}000{,}000/L^{2}$‡	$550{,}000{,}000/L^{2}$‡
Max. operating torque, ft.lbf [N.m]	24,000 [32,539]	65,000 [88,128]
Mud properties		
Max. lost circulation material	No limit	No limit
Max. sand content, %	1	1

† Pressure drop, psi = [(mud weight, lbm/galUS) × (flow, galUS/min)²]/C.
‡ L = the distance (ft) from the bottom of the stabilizer blades immediately above the OptiDrill service sub to the top of the stabilizer blades immediately below the OptiDrill service sub.

Data Acquisition and Processing	
Sample rate	19 channels at 10,000 Hz
Digital signal processor	180 Mflops
Processing time	2-s window
Real-time telemetry	Fully compatible with Orion II* data compression platform and the IntelliServ® Network™
Downhole memory	
Low frequency	200 MB (250 h at 0.5 Hz [configurable])
High frequency	1,500 MB (140 h at 50 Hz [fixed])
Power supply	Low-power tool bus (LTB) and battery (75 h) Power-saving mode Trip-in time Battery-saver time

Specifications

OptiDrill 675 Service

Measurement	Sensor	Real-Time Range	Recorded-Mode Range	Real-Time Resolution	Recorded-Mode Resolution	Accuracy	Real-Time Processing	Recorded-Mode Processing	Bandwidth
Weight on bit†	Strain gauge	±75,000 lbf [±333,616 N]	±93,000 lbf [±413,684 N]	300 lbf [1,334 N]	50 lbf [222 N]	±3,000 lbf [±13,344 N]	10-s moving window	2-s moving window	200 Hz
Torque†	Strain gauge	±24,000 ft.lbf [32,540 N.m]	±30,000 ft.lbf [40,675 N.m]	100 ft.lbf [135 N.m]	7 ft.lbf [9 N.m]	±1,000 ft.lbf [±1,355 N.m]	10-s moving window	2-s moving window	200 Hz
Bending moment†	Strain gauge	61,000 ft.lbf [82,705 N.m]	76,000 ft.lbf [103,042 N.m]	120 ft.lbf [163 N.m]	5 ft.lbf [7 N.m]	±3,000 ft.lbf [±4,067 N.m]	10-s moving window	2-s moving window	200 Hz
Vibration	Accelerometer								
Axial (x)		0 to 31.75 g_n	0 to 31.75 g_n	0.125 g_n	0.007 g_n	±0.25-g_n rms	30-s rms	30-s rms	0.2 to 150 Hz
Lateral (y and z)		0 to 63.50 g_n	0 to 63.50 g_n	0.25 g_n	0.007 g_n	±0.25-g_n rms	30-s rms	30-s rms	0.2 to 150 Hz
Rotational speed	Magnetometer and gyroscope	–500 to 1,000 rpm	–500 to 1,000 rpm	1 rpm	<1 rpm	±5 rpm	30-s moving window	2-s window	4 Hz
Annular and internal pressure	Strain gauge	30,000 psi	30,000 psi	1 psi	<1 psi	±30 psi	1-s avg	2-s window	200 Hz
Annular and internal temperature	PT1000	–50 to 204 degC	–50 to 204 degC	1 degC	0.04 degC	±1 degC	1-s avg	2-s window	10 Hz
Continuous inclination	Accelerometer	0° to 180°	0° to 180°	0.1°	0.1°	±0.4°	30-s avg	30-s window	10 Hz

†Weight on bit, torque, and bending moment are compensated downhole for temperature, differential pressure, and hydrostatic pressure.

OptiDrill 900 Service

Measurement	Sensor	Real-Time Range	Recorded-Mode Range	Real-Time Resolution	Recorded-Mode Resolution	Accuracy	Real-Time Processing	Recorded-Mode Processing	Bandwidth
Weight on bit†	Strain gauge	±125,000 lbf [±556,027 N]	±156,000 lbf [±693,922 N]	500 lbf [2,224 N]	80 lbf [355 N]	±4,000 lbf [±17,792 N]	10-s moving window	2-s moving window	200 Hz
Torque†	Strain gauge	±81,000 ft.lbf [109,821 N.m]	±101,000 ft.lbf [136,938 N.m]	320 ft.lbf [434 N.m]	17 ft.lbf [23 N.m]	±2,000 ft.lbf [±2,712 N.m]	10-s moving window	2-s moving window	200 Hz
Bending moment†	Strain gauge	132,000 ft.lbf [178,968 N.m]	165,000 ft.lbf [223,710 N.m]	260 ft.lbf [353 N.m]	11 ft.lbf [15 N.m]	±6,000 ft.lbf [±8,135 N.m]	10-s moving window	2-s moving window	200 Hz
Vibration	Accelerometer								
Axial (x)		0 to 31.75 g_n	0 to 31.75 g_n	0.125 g_n	0.007 g_n	±0.25-g_n rms	30-s rms	30-s rms	0.2 to 150 Hz
Lateral (y and z)		0 to 63.50 g_n	0 to 63.50 g_n	0.25 g_n	0.007 g_n	±0.25-g_n rms	30-s rms	30-s rms	0.2 to 150 Hz
Rotational speed	Magnetometer and gyroscope	–500 to 1,000 rpm	–500 to 1,000 rpm	1 rpm	<1 rpm	±5 rpm	30-s moving window	2-s window	4 Hz
Annular and internal pressure	Strain gauge	30,000 psi	30,000 psi	1 psi	<1 psi	±30 psi	1-s avg	2-s window	200 Hz
Annular and internal temperature	PT1000	–50 to 204 degC	–50 to 204 degC	1 degC	0.04 degC	±1 degC	1-s avg	2-s window	10 Hz
Continuous inclination	Accelerometer	0° to 180°	0° to 180°	0.1°	0.1°	±0.4°	30-s avg	30-s window	10 Hz

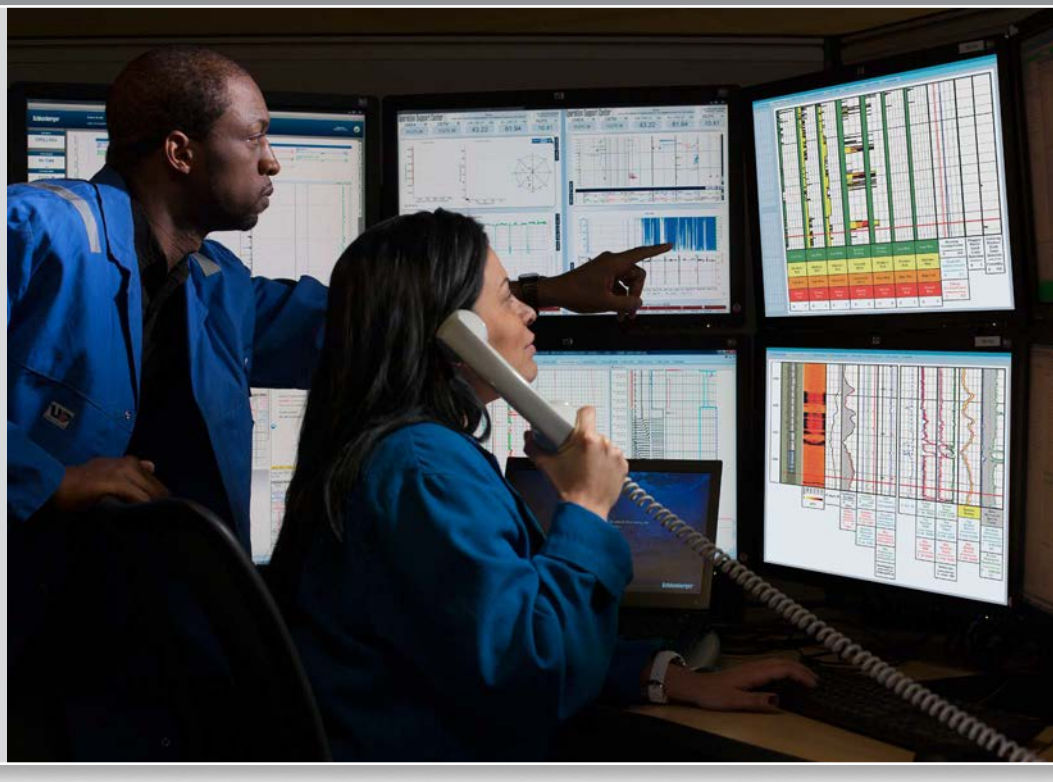
†Weight on bit, torque, and bending moment are compensated downhole for temperature, differential pressure, and hydrostatic pressure.

Find out more about the OptiDrill service at slb.com/OptiDrill

Animation
Watch an animation that shows how the OptiDrill service provides actionable information to mitigate drilling risk and increase efficiency.

Case Study
Total eliminates a planned bit run with OptiDrill service in a 17½-in section in the North Sea.

Tech Report
OptiDrill service improves BHA reliability to help an operator drill to section TD in one run in deepwater Gulf of Mexico.



slb.com/OptiDrill

†Japan Oil, Gas and Metals National Corporation (JOGMEC), formerly Japan National Oil Corporation (JNOC), and Schlumberger collaborated on a research project to develop LWD technology that reduces the need for traditional chemical sources. Designed around the pulsed neutron generator (PNG), EcoScope service uses technology that resulted from this collaboration. The PNG and the comprehensive suite of measurements in a single collar are key components of the EcoScope service that deliver game-changing LWD technology.

Schlumberger