Broadband Networked Drillstring
For High-Definition Downhole Data, Along String Evaluation and System Integration

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Some quick answers to burning questions

1. First wired-system to market, patents dating from the 1940’s
2. Largest Oilfield Manufacturer and Largest Service Company Support JV
4. Jobs, worked in 4 continents, 4 service companies (BHI, SLB, HAL, WFT)
5. Facilities – Provo, Navasota, Aberdeen, Villahermosa, Trinidad + Container R&M
6. 5/8” Pipe size available, in addition to 4”, 5” and 5 7/8”
10. Years broadband networking – Commercial Launch in Jan 2006
45. % minority interest of SLB; maintain open network
57. kbps broadband network, 2 mbps field tested
95. % Uptime in H1
450. Thousand feet of Networked Pipe in portfolio
1,000,000. Feet deployed, 87 wells, 23 different rigs
30,000,000. Drill Pipe Device-Hours
Today’s Well Construction Challenges

Mud Pulse

- Safety
- Cost control
- Consistent performance
- Deep reservoirs, complex wells
- Narrow pore-frac window

- Need for downhole data
- Need for downhole tool control
- Need for system integration

... Lagging bi-directional telemetry

IntelliServ Broadband Network

- 57,600 bits/sec
- Simultaneous data
- High bandwidth
- High volume
- Real time
- Continuous bi-directional data transfer
- Tool actuation

- Vibration
- Sonic
- Image Logs
- Etc Etc
System Components

1) Armored coax cable

2) Induction coils

3) Boosters
Broadband Telemetry for Downhole and Along String Measurements

- Broadband Telemetry
- Field Specialists
- Bi-directional tool communication
- Down-hole tool actuation services
- Network diagnostics
- Software displays
- Inventory management
- Support from central technology support hub

Equipment
- DP
- HWDP
- NM DC, DC
- Jars
- Reamers
- Saver subs
- Crossovers

Telemetry Service

Managed Service

People, Processes

Pipe/Coil + Coax

BHA / Along String

Measurements

Service Companies:
- BH, HAL, SLB, WFT
- Interface Sub

IntelliServ
- Temperature, Annular Pressure, Internal (bore) Pressure
IntelliServ Capabilities
Capability #1: High Speed, Broadband

Because downhole signals are transmitted and evaluated as time-series measurements, they have to be measured quickly enough to ensure they can be accurately defined.

1. Vibration Mitigation
2. Wellbore Imaging

Nyquist Theorem
Broadband speed enables high-frequency signal definition

~40 Hz

Courtesy: NOV Downhole, Blackbox recorded data
Broadband speed enables high-frequency signal definition

~40 Hz

Courtesy: NOV Downhole, Blackbox recorded data
Broadband speed for high-definition wellbore imaging

Gamma Image 4 sector drilling at 30 ft/hr passing a fault (Mud Pulse)

Gamma Image 8 sector while drilling at 200 - 300 ft/hr
Broadband for high-definition logs in real time

Improved log quality reduced geological uncertainties

Redundant telemetry systems permit continuation

Sub surface risks evaluated in real time including time lapse or 4D logging

**Mud Pulse best case:**
Ream down 60 ft/hr
1 pt/ft –4 sector.
The 4 sector image “averages out” the breakout.

**Wired Pipe:**
Ream down at 320 ft/hr
2 pts/ft –16 sector

Courtesy: BakerHughes
**Capability #2: Measurements beyond just at the bit**

Distributed measurements provide additional insight of what is happening along the miles of pipe and help avoid potentially trouble.

1. Event Detection
2. UBD / MPD
Along-string evaluation for kick detection

**Kick Detection (Large Annulus)**

- **PRESSURE GRADIENT CHANGE IN AN INTERVAL?**
  - **Y**
  - **BORE, ANNULAR PRESSURE DECREASE IN AN INTERVAL?**
    - **Y**
      - **WELLBORE INFLUX***
    - **N**
      - **CONTROL INFLUX (SHUT IN OR DYNAMIC WELL KILL)**
  - **N**

**Operations Continue**

### Diagram:

- **Sensor #1**
- **Sensor #2**
- **Sensor #3**

- **Δ ≈ Δ ≈ Δ ≈ Δ**
- **Δ ≈ Δ Δ Δ**
- **Δ ≈ Δ Δ Δ**

**ANNULAR PRESSURE SENSOR**
Along-string evaluation for event detection

**Kick Detection (Large Annulus)**

1. **Pressure Gradient Change in an Interval?**
   - **Y**
     - Bore, Annular Pressure Decrease in an Interval?
       - **Y**
         - Wellbore Influx
       - **N**
         - Operate
       - **N**
         - Control Influx (Shut In or Dynamic Well Kill)
     - **N**
2. **Operate**

**Pack-Off**

1. **Annular Pressure Gradient Increase in an Interval?**
   - **Y**
     - Pressure Increase in an Interval?
       - **Y**
         - Cutting Build-Up
       - **N**
         - Work drillstring, Circulate to reduce pressure gradient
   - **N**
2. **Return**
Along-string pressure evaluation
Pack-off detection in deepwater
Along-string hole cleaning evaluation
Along-string evaluation for UDB, nitrogen
Capability #3: Surface system integration

Distributed measurements provide additional insight of what is happening along the miles of pipe and help avoid potentially trouble.

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1. Downlinking
2. Trip Speed Optimization
3. Rotary Steerable
1. Trip Speed Optimization based on Swab/Surge Measurement

2. Control drawworks speed based on tension/compression

Measurement While Tripping
Measurement While Tripping

1. Trip Speed Optimization based on Swab or Surge Measurement

2. Control drawwork’s speed based on tension or compression measurement
Today’s Capabilities
(Near) Future Capabilities

- 2.0 Mbps field test 10/’09
  - 653 Gigabits transmitted
  - 240 kbps maximum data rate
  - 199 ft BHA with 12 tools

Along String Evaluation for:
- Cementing
- Casing Running
- Perforating
- Completions
- Testing
- Early production

- Drawworks
- Heave compensation
- Mud Pump startup, shut down
- Auto-Choke
- Topdrive systems
Thanks to our Service Partners

Questions?
Bio – Daan Veeningen

Daan Veeningen has more than fifteen years of international oilfield experience. Daan has extensive operational experience in well construction operations in three continents. Further, Daan developed drilling engineering tools and marketed Schlumberger services with real time capabilities. At NOV, Daan has been responsible for business development and marketing for the IntelliServ broadband networking and along-string evaluation services for high-definition downhole and sub-surface operations for the last two years. Daan holds a masters degree in petroleum engineering from the Delft University of Technology and has been awarded numerous patents for drilling systems and processes.