MUX Control of subsea BOP without an Umbilical
Acoustic-based MUX for BOP control

- The challenges of subsea acoustics
- Benefits
- Objectives
- Example
- Design strategies
- Qualification
- Conclusions
Subsea acoustics

• There are many challenges in designing subsea acoustic systems:
  – Multipath effects
    • There are reflections from hard surfaces and water layers
  – Signal to noise ratio
    • Systems are often used on dynamically positioned rigs where noise in the water under the rig is an issue
  – Range & Bandwidth
    • Long range requires low frequencies, which do not support high data rates
  – Interference
    • Acoustics are used for many other subsea applications, including vessel positioning and construction activities. The systems used to support all these activities must not interfere with each other
  – Latency
    • The rule-of-thumb for the speed of sound through water is 1,500 ms⁻¹
  – Refraction
    • Sound waves do not generally travel in straight lines through water
Present situation

• Although it is a niche area, there are three companies supplying acoustic systems in support of drilling operations

• Those applications for blowout preventer (BOP) equipment include
  – Back-up control of key functions
  – Commanding emergency disconnect sequences
The benefits of an acoustic solution for MUX communication include:

- Improvement of health and safety by eliminating moonpool handling of umbilical as riser run out
- Elimination of downtime caused by umbilical damage
- Elimination of umbilicals and reels (cost & handling)
- Reduction in deck space requirement
What are the objectives?

- Acoustic primary control of subsea BOP
- Around 120 functions, dozens of analogue readings and digital status signal per function
- Replace the traditional control umbilical
- Retain the existing, proven, Cameron surface and subsea control units
Data Types

• Signals from surface to subsea
  – single valve command
  – regulate command
  – multiple valve command

• Data sent from subsea to surface
  – single valve command answer
  – regulate command answer
  – multiple valve command answer
  – valve states
  – analogue data
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NASHUX
NASHUX is an acoustic system providing full control for subsea Blow Out Preventer (BOP) equipment and offers an alternative to traditional multiplexed (MUX) control systems. NASHUX replaces the command, control and monitoring aspects of a central umbilical with an acoustic system which requires very little cable equipment. As a result, immediate benefits are realised, including: flexibility to transfer the system from site to site; quick, safe and efficient control; increasing available deck space and reductions in handling and transportation costs.

NASHUX features include high function count, digital interface, analogue signals for information such as pressure readings, and several programmable sequences for single-command activation of sequences such as emergency disconnect. The system is a collaborative venture between Neutronix, Aberdeen, Scotland and Cameron Drilling Systems, Houston, Texas.

The underlying technology (Neutronix' proprietary Acoustic Digital Spread Spectrum signalling) has been proven, over ten years of successful subsea operations, as a highly reliable and extremely robust technology for addressing the kind of mission-critical requirement. This track record includes a previous Cameron - Neutronix collaboration for control of small-scale subsea isolation devices.

Neutronix holds the Intellectual Rights to the technology, but has an agreement with Cameron for exclusive use of the solution within the oiling arena.

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Current example - NASBOP

- NASBOP is an acoustic communication system for the command, control and monitoring of subsea isolation devices, such as Cameron’s Environmental Safeguard (ESG) unit.

- It provides the primary or secondary link between the topside operator and the subsea equipment.

- Regular monitoring, as well as emergency disconnect control.
• An enabling technology for Surface BOP drilling
NASBOP Summary

- 8 function control system
- Digital readback for solenoid status
- Analogue reading
- Housings rated to 3,500 msw
- Primary or secondary control
- Subsea equipment redundancy
- Optional wired connection
  - Surface power
  - Surface signal
Equipment – typical configurations
NASBOP & ESG on Stena Tay (2004)

- Subsea Control Units (SCU)
- Transducers

Cameron’s Environmental Safeguard (ESG)
• Acoustic command of planned disconnect
  – Egypt 2004
  – 2,438 msw (8,000’)

(Courtesy of Shell)
Intelligent Data Management

- Although acoustic data rates are low, there is much that can be achieved through the application of intelligent data management.

- Instead of sending all data, filter intelligently (report on exception):
  - On change
  - On rate of change
  - On scale of change
  - On direction of change
  - Using lower sampling rate

- Strategies like these will generally provide all the information needed to make informed decisions, track trends, monitor equipment and manage operations.
Implications for existing MUX

• Interfaces to the acoustic system
  – Topside
  – Subsea

• Move some intelligence subsea
  – e.g. regulator control

• Optimise data protocol for acoustic transmission
Subsea Power Requirements

- A consequence of removing the umbilical is the need to provide subsea power
  - Electrical
  - Hydraulic
- Electrical requirements
  - Can be met through the use of commercially available equipment
- Hydraulic requirements
  - Cameron is looking at innovative techniques that utilise fluid flow, as well as its previously announced Seawater Powered Actuator (SPA)
Qualification

- It is important that systems that advance the limits of what is possible are based on sound design, analysis and testing.

- Guidelines exist for the development and qualification of such systems.

Technology qualification is defined as: “the process of providing the evidence that the technology will function reliably within specified operational limits with an acceptable level of confidence”.

### Qualification Process

- Define Qualification Basis
- Technology Assessment
- Failure Mode Identification and Risk Ranking
- Concept Improvement
- Selection of Qualification Methods
- Success Evaluation
- Data Collection (Analysis and Testing)
- Functionality Assessment

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**Qualification Work Process**

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**Development Project Milestones**

- TA
- TQP
- TQP?

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**DNV Deliverables**

- Technology Assessment Report
- Technology Qualification Plan
- Technology Qualification Report

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**Flowchart**

- Yes
  - Technology Qualification Report
- No
  - Hold or fall-back solution

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**Notes**

- NAUTRONIX MARINE TECHNOLOGY SOLUTIONS
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Interference / signal security

- The spread spectrum method used is based on direct sequence spread spectrum (DSSS) and is called Acoustic Digital Spread Spectrum (ADS²)
  - Designed so that messages to other units in an ADS² field appear to be less significant than background noise

- To illustrate the probability of a unit 'picking up' a message meant for another unit, a worst case scenario has a matching signal produced randomly by biological or man-made noise

- Data are sent as a series of codes, with each audible noise burst being a single code. These codes are combined to send commands and telemetry
Assuming that NASBOP uses 100-chip codes (this low number is for illustrative purposes only), the following is the sequence of events required to activate an EDS (Emergency Disconnect Sequence) of a NASBOP system:

1. First, the system needs to receive a proprietary Telemetry Alert signal.

2. The system then needs to match the received data against a 100-bit code to confirm that the message that follows is directed at that specific subsea unit.
   - This can be represented as 25 hexadecimal digits, e.g. D74FC061F566719A4552EF0B4
Next, the system needs to match four further codes which make up the EDS command, e.g.

- 29216D03BB7EE417A345B3306
- F83491C38E69ACACB776E28B3
- 935222F041694527429E26849
- 8950508205E9DBA5B3D80FAD5

These four codes have to arrive in the correct order.

Finally, the system receives a parity code, e.g.

- 1988D313BAB473290E596C24E
- Which confirms that the message has not been corrupted

Only if the station receives a valid message at all of the foregoing stages will a disconnect be initiated.
Status

- FEED (Front End Engineering Design) study completed Q1 2009
- Phase I of development commenced July 2009, due by year end
Conclusion

• Subsea acoustic systems have been used in support of drilling applications for many years

• Modern digital systems are highly advanced and are able to offer security, reliability and integrity at an appropriate level such that applications like full subsea BOP control are possible

• The safety, operational and financial benefits of replacing umbilicals with acoustic communications are clear

• There will be challenges in this programme, both technical and in gaining industry acceptance of the system
‘Global Leaders in Through Water Communication and Positioning Technology for the Offshore Industry’
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