Subsea Internet of Things

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WFS Technologies
Subsea Controls Down Under
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Subsea Internet of Things

- Agenda

• About WFS Technologies
• Seatooth Technology
• What is the Subsea Internet of Things?
• Applications:
  – Asset Integrity
  – Flow Assurance
• Summary

Seatooth PipeLogger
- Smart, Wireless Pipeline Temperature Logger
About WFS Technologies

- **Background**

  - Founded Edinburgh, Scotland in 2003
  - Privately owned
  - Head office Edinburgh, Scotland
    - Sales/Projects offices in Houston, Vietnam
  - World leader in radio based subsea wireless automation
  - Seatooth radio technology developed in-house
    - >200 man-years of research
  - >7000 Seatooth products delivered
  - WFS Oil & Gas
    - Asset Integrity Solutions
    - Flow Assurance solutions
    - IRM
  - WFS Defense
    - Diver wireless Personal Area Networks (wPAN)
    - AUV communications and docking

*WFS Headquarters, nr Edinburgh, Scotland*

*Seatooth Wireless Network*
About WFS Technologies

- **Seatooth Technology**

**Diagram:**
- Propagation through Water-Air Boundary
- Radio finds path of least resistance

**About WFS Technologies - Seatooth Technology**

- **Seatooth: radio communications**
  - Media: water, water/air boundary, seabed, ice, metal
  - Attenuation is a function of frequency & conductivity
    - $\approx 55$ dB/λ in seawater
  - Propagation velocity is a function of frequency:
    - $\approx 100$x velocity of sound at 3kHz in seawater

- **Propagation loss through water/air boundary** $\approx 3$ dB
- Unaffected by turbidity, biofouling, aeration, thermal layers, engine noise
- Ultra low power receive technology key to deployments of 10 years +
Subsea Wireless
- Comparison of options

- Complementary wireless technologies
  - Acoustic
  - Radio
  - optical

- There is no ‘silver bullet’
- Select technology that best matches application
- Future of subsea wireless is Hybrid

### Pros

<table>
<thead>
<tr>
<th>Technology</th>
<th>Acoustic</th>
<th>RF</th>
<th>Optical</th>
</tr>
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</table>
| **Pros**   | • Proven technology  
  • Range: up to 20 km  
  • Energy efficiency at longer ranges  
  • Precision navigation | • Unaffected by water depth  
  • Unaffected by turbidity/bubbles  
  • Non-line-of-sight performance  
  • Omni-directional  
  • Rapid set-up  
  • Low latency  
  • Immune to acoustic noise  
  • Immune to marine fouling  
  • Up to 100 Mbps  
  • Transmits underwater & water/air | • Ultra-high bandwidth  
  • Compact  
  • Low latency  
  • Immune to acoustic & EMI noise |

| **Cons**   | • Adversely affected by  
  • Water attenuation  
  • Ambient noise  
  • Multi-path in shallow water  
  • Unpredictable propagation  
  • Limited bandwidth  
  • High latency  
  • Impact on marine life  
  • Does not transmit underwater | • Limited range through water  
  • Low energy efficiency at longer ranges  
  • Susceptible to in-band EMI | • Susceptible to turbulence & particles  
  • Marine fouling on lens faces  
  • Line-of-sight  
  • Needs tight alignment  
  • Short range  
  • Difficulty transmitting underwater |

Source: Subsea Wireless Group (SWiG), 2013
SWIG is an open standards JIP feeding into API 17F
What is the Subsea Internet of Things?

- **Subsea Internet of Things**: is a network of smart, wireless sensors and devices configured to provide performance, condition and diagnostic information.
What is the Subsea Internet of Things?

- Smart Devices

- Multi-parameter sensor
  - Asset Integrity: Temp, UT, CP, Vibration
  - Flow Assurance: Temp, Flow, Vibration
- Local data processing
- Local process model correction
- Intelligent power management
- Local power generation
What is the Subsea Internet of Things?

- Wireless

- Wireless = Hybrid incorporating wireless
  - Hard wired
    - Copper
    - Fibre optic
  - Wireless
    - Radio
    - Acoustic
    - Free space optics

- Select the most appropriate technology
  - Cost
  - Resilience
  - Performance
  - Flexibility
What is the Subsea Internet of Things?

- Information

- Smart devices process data to deliver information
  - derived values, control outputs, graphs, histograms,

- Information v data
  - **Data** are the facts or details from which **information** is derived. Individual pieces of data are rarely useful alone. For data to become information, data needs to be put into context.

- Why **Information**?
  - Reduced cost
  - Extended life
  - Increase resilience
  - Distributed control

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### Flowline Temperature

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Convert data to Information
Subsea Internet of Things
- Applications

• **Asset Integrity**
  – Field-wide Cathodic Protection (CP)
  – Pipe wall thickness (UT)
  – Crack (ACFM)
  – Vibration
  – Impressed Current (ICCP)
  – Flow induced pulsation (FLIP)
  – Riser fatigue
  – Completion fatigue
  – Mooring fatigue
  – Leak detection

• **Production Optimisation & Flow Assurance**
  – EOR water/gas injection
  – Hydrate/wax
  – Chemical injection
  – Slug management
Subsea Internet of Things
- Asset Integrity

CP Inspection Automation

- Reduce inspection costs
- Improve quality of information
- Flexibility to extend sensor network

→ extend interval between inspection
→ location, timeliness, reliability, frequency
→ subsea wireless SCADA
Subsea Internet of Things

- Asset Integrity

Pipeline Corrosion Monitoring with PIG

- Use PIG as ‘AUV on tram tracks’ to harvest data from remote sensors
- Seatooth PigTracker supports low bandwidth, 2-way comms through up to 50mm steel
- WFS solution
  - Smart sensor on outside of pipe takes periodic readings (eg UT, temp, flow, vibration)
  - Local data processing
  - Data harvested by PIG
- Benefits
  - Reduced OPEX: vessel time
  - Improved quality of information
  - Improved safety
Subsea Internet of Things
- Asset Integrity

FIV/VIV/Free-Span Monitoring

- Reduce data monitoring costs ➔ extend interval between battery swap-outs
- Improve reliability of data collection ➔ verify system performance without recovering logger
- Flexibility to extend sensor network ➔ subsea wireless SCADA
Subsea Internet of Things

- Flow Assurance

EOR Water/Gas Injection Control

- Increase production
- Extend reservoir life
- Solution
  - Retrofit wireless network of smart flow meters
  - Implement control strategy
Subsea Internet of Things
- Production Control

- Reduced CAPEX ➔ lower electrical load, reduced installation cost
- Increased reliability ➔ fewer connectors and jumpers
- Increased flexibility ➔ futureproof control system expansion
Summary

• Subsea Internet of Things
  – Hybrid architecture
  – Smart wireless sensors
  – Local data processing and control
  – Seamless extension of wireless through splash zone

• Benefits
  – Increase production
  – Reduce CAPEX
  – Reduce OPEX
Thank You

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