Reducing Costs Through Subsea Wireless Automation

Subsea Cloud Computing & Subsea Internet of Things®

WFS Technologies
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Abstract

This paper explores the latest subsea wireless products and automation technologies including hybrid wireless, Subsea Internet of Things and Subsea Cloud Computing and their use to increase production, reduce operating costs, reduce asset integrity management costs and extend asset life.
WFS Technologies

- **Background**

- Founded Edinburgh, Scotland in 2003
- Locations: Edinburgh, Houston, SE Asia
- World leader in subsea wireless automation
  - Seatooth radio
  - Seatooth Hybrid: radio, acoustic, optical
    - >200 man-years of research
    - >40 US patents granted
  - >7000 Seatooth products delivered
- Subsea Internet of Things®
- Subsea Cloud Computing

- **WFS Oil & Gas**
  - Production optimisation solutions
  - Asset integrity monitoring solutions

- **WFS Defense**
  - Subsea wireless C4ISR
Why Subsea Automation Matters

- Onshore/dry tree efficiency typically 50% greater than offshore – why?
  - High cost of intervention?
  - Low levels of automation
    - est >80% less investment; 90% fewer sensors
    - Less instrumentation = less data
  - Predictive models uncalibrated
    - Eg Flow, fatigue, corrosion, met-ocean etc
    - Over-design
    - Excess conservatism
    - Low extraction efficiency

- How Subsea automation drives down Costs
  - Collapse cost of critical information
    - Increase production efficiency
    - Reduce inspection costs
    - Extend asset life
    - Lower field extension costs
    - Lower green field CAPEX/OPEX

Source: WSJ, Apr 16  http://graphics.wsj.com/oil-barrel-breakdown/
Evolution of Automation

**Subsea Automation**
- Manual Inspection
- Diver Inspection
- RO Inspection
- AUV Inspection

**Process Automation**
- Manual Inspection
- Local PID Control
- Plant-wide SCADA/DCS
- Industrial IoT GE Predix
- Mobile Cloud Computing

DCS dream taking flight
ExxonMobil envisions a new "system of systems" that will allow it to more easily adapt its operations environment to change needs and opportunities. Graphic by ExxonMobil.

Advances in Wireless Technologies

Impact of water quality on wireless performance

Optimum operating environment of wireless technologies

Battery life of wireless technologies

- Optical
- Radio
- Acoustic
Advances in Wireless Technology
- Collapsing the cost of critical information

Driving without a fuel gauge....

Access to information changes behaviours

- **Battery life**: 6 months ➔ 5-20 yrs
- **Transit splash zone**: Cabled ➔ Wireless
- **Reliability**: Connectors ➔ Sealed for life
- **Installation**: Work class ROV/Vessel ➔ Light class ROV/Platform
- **Integration complexity**: High (wired) ➔ Low (wireless)
- **Information recovery**: Diver/WCROV ➔ Wireless network/LCROV/AUV/PIG

Seatooth PipeLogger
- Retrofit Smart Temperature Controller
What is **Subsea Internet of Things**?

A network of smart wireless sensors and devices configured to provide actionable operational intelligence such as performance, condition and diagnostic information.

**Underpinning innovations**

- **Seatooth Radio** - penetrates water, water/air, seabed, metal
- **Seatooth Hybrid** - integrated radio, acoustic, optical comms
- **Seatooth Endure** - extends battery life beyond 10 years
What is Subsea Internet of Things?

- **Smart Devices**

  - Multi-parameter smart sensor
    - Flow Assurance: Temp, Flow, Vibration, Acoustic (slug)
    - Asset Integrity: Temp, UT, CP, Vibration, Crack, Video/Acoustic/sonar/hydrocarbon (leak),
  
  - Hybrid communications
    - Wireless radio, acoustic, optical
  
  - Intelligent bandwidth management
    - Local data processing ➔ low data density
    - Local process model correction ➔ 'fog' computing
  
  - Intelligent power management
    - Intelligent bandwidth management ➔ 5-20 years
    - Local power generation using dT ➔ 20 years +
Subsea Internet of Things
-Wireless automation solutions using standard sensors-

- Seatooth PipeLogger
  Non-penetrating temp controller
  Process and seawater temp
  Temp: 0-100DegC +/- 2DegC
  Battery: up to 20 years

- Seatooth PipeLogger-TI
  Non-penetrating temp controller
  Pipe-in-pipe or up to 4” foam
  Temp: 0-100DegC +/- 5C
  Repeatability: 1DegC
  Battery: up to 20 years

- Seatooth PipeLogger-UT
  Retrofit corrosion monitor
  Wall Thickness: <250mm
  UT Accuracy: 0.1mm
  Up to 8 UT sensors
  Battery: up to 20 years

- Seatooth WiPS
  Wireless Pressure/Temp
  Integrated display

- Seatooth Video
  Subsea wireless camera
  Battery: up to 8 hrs use
  Seawater Range: 3-5m

- Seatooth SWiCOM
  Subsea wireless diver automation
  Seatooth wireless Android tablet
  Battery: up to 8 hrs continuous
  Seawater Range: 5-10m

- Seatooth PipeLogger-UF
  EOR automation
  Accuracy: +/- 2-5%
  Repeatability: +/- 2%
  Battery: up to 10 years

- Seatooth CP
  Corrosion automation solution
  Stork Voltage/Current sensor
  Battery: up to 20 years

- Seatooth CTFM
  Fatigue management
  Real time & cumulative

- Seatooth Vibration
  Fatigue, VIV, FIV monitoring
  Up to 1kHz
  Battery: up to 5 years

- Seatooth LightRope
  Subsea wireless RFID
  For diver and ROV automation
  Battery: 16 hrs use; 2 yr standby
  Seawater Range: 5m

- Seatooth Smart Clamp
  For risers and flowlines
  Suitable for splash zone
  Deployable by light class ROV
  Self-monitoring
Subsea Internet of Things
- Smart Communications

• Seatooth Hybrid:
  – Integrated radio, acoustic, optical
  – Auto channel selection
  – Battery life: up to 20 years

• Benefits
  – Single solution for all operating environments

• Applications
  – Asset integrity management
  – Production optimisation
  – Green field CAPEX/OPEX reduction
What is Subsea Cloud Computing?

Is a secure and efficient computing architecture based on Subsea Internet of Things that provides shared computer resources and data to subsea devices on demand.

- Subsea automation data sets >>TB
  - Production, asset integrity, seismic, downhole, met-ocean etc.
- Hardwiring every sensor impractical: cost, reliability, future proof
- Hybrid architecture
  - Cf telecoms fibre optic to 4G mast
- Move Intelligence to the edge
- Resilience:
  - Overlapping radio, acoustic network;
  - AUVs ‘fill gaps’, ‘cross-pollinate’ critical information & synchronise large datasets
- Security: Blockchain manages access to subsea cloud ‘servers’
Subsea Cloud Computing
- Extended capability with Autonomous Vehicles
Subsea Internet of Things
-Wireless Automation Solutions – Key Application Areas

• Process Optimization
  – Real time point & distributed temperature
  – EOR Water/Gas injection optimization
  – Slug management
  – Hydrate/Wax management
  – Chemical injection optimization

⇒ Increase production by up to 15%
⇒ Decrease chemical costs by up to 50%

• Asset Integrity Automation
  – Riser/completion fatigue monitoring
  – Mooring fatigue monitoring
  – Field-wide corrosion optimization (CP)
  – Point corrosion/Erosion automation (UT)
  – Crack inspection automation (ACFM)
  – Impressed Current optimization (ICCP)
  – Vibration Management (FLIP, VIV, Span)
  – Leak detection

⇒ Reduce costs by up to 90%
Subsea Internet of Things – Process Optimization
- Increase production, Reduce Chemical Costs

• Modelling tools used for design, process & asset management often uncalibrated against field data
  – Flow
  – Temperature
  – Corrosion
  – Fatigue

• Lack of calibration leads to conservatism
  – Increased CAPEX
  – Sub-optimal production
  – Increased OPEX

• Improve system characterisation through model calibration
  ➔ Distributed temp, corrosion, fatigue sensors

• Reduce latency of actionable information
  ➔ Wireless SCADA network

• Improve control
  ➔ Dynamic models linked to real time data
  ➔ Closed loop Chemical/EOR injection control
Subsea Internet of Things
- Process Optimization ➔ Real time point & distributed temperature

- **Point Temperature Monitoring**
  - Broken well-head sensor replacement
  - Riser base
  - Flexible inlet
  - Hot/cold spots
  - Seawater temperature

- **Distributed Temperature monitoring**
  - $dT$ across pipe-in-pipe
  - $dT$ across buried pipe
  - $dT$ across cooling spool
  - Seawater temperature through water column

- 5 DegC reduction in margin
  ➔ Production +800 bpd /+15%
  ➔ $15m pa @ $50/bbl

Source: Xodus
Subsea Internet of Things
- Reduce Inspection costs and detecting failures

• Inspecting what?
  – Leaks, Corrosion, Cracks, Fatigue, Movement

• Why so few asset integrity sensors?
  – High cable installation costs
  – Poor reliability of connectors & jumpers
  – Battery swap costs
  – High cost of repair

• Inspection cost drivers:
  – Diver ➔ DSV costs, safety, complexity
  – ROV ➔ ROV spread costs, complexity

• Regulatory driven

• Low data density ➔ limited root cause analysis

Benefits of Subsea Internet of Things
• Reduce inspection costs by >50%
• Reduce installed sensor cost by >80%
• Reduce information latency
• Increase data density by >10^2
• Increase repeatability, accuracy, resolution
• Reduce AIM maintenance/repair costs
• Extend asset life
Asset Integrity Solutions
- Subsea Field-Wide Cathodic Protection (CP)

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

- payback typically < 1 year
- location, timeliness, reliability, frequency
- subsea wireless SCADA
Subsea Internet of Things
- Real Time Wireless Riser Monitoring Solution

Functions

- User interface: Real time & cumulative fatigue, corrosion wax/hydrate, temperature, water currents
- Fatigue: Riser shape & motion; VIV
- Corrosion: Corrosion rate by region
- Flow assurance: Wax/hydrate management
- Environment: Water currents, temp, salinity

Features

- Sensor nodes: Up to 100
- Comms: Hybrid (radio, acoustic, optical)
- Battery life: 5 – 20 years
- Deployment: Using light or work class ROV
- Clamps: Self-monitoring (Smart)
- Interfaces: Real time meteorological data FPSO DCS/SCADA
Subsea Internet of Things
- Real Time Mooring Monitoring Solution

Functions
• User interface: Mooring & anchor status
  Real & cumulative time fatigue
  Water currents, temperature & salinity
• Failure: Mooring line failure
  Suction anchor failure
• Fatigue: Mooring system fatigue monitoring
• Corrosion: Corrosion rate by region
• Environment: Water currents, temp, salinity

Features
• Comms: Hybrid (radio, acoustic, optical)
• Battery life: Minm 5 years
• Deployment: Using light or work class ROV
• Clamps: Self-monitoring
• External links: Real time meteorological data
  FPSO DCS/SCADA

Facilities FPSO, TLP, SPAR, Semi-sub
Subsea Internet of Things
- Subsea Field Leak Monitoring Solution

- Retrofit Wireless SCADA network
- Seatooth Hybrid Smart Controller sensor options
  - Leak
    - Acoustic (leak detection)
    - Photo/Video
    - Capacitive (leak capture)
    - Sonar
  - Asset integrity
    - Accelerometer (movement)
    - Corrosion (CP, UT)
  - Flow Assurance
    - Temperature (process and sea)
    - Flow (process)
- Seatooth Hybrid communications
  - Radio
  - Acoustic
- Local data processing
- Integration with SCADA/DCS
- Light-class ROV deployable
- Battery life: typically 5 years
Summary and Conclusions

- Low levels of subsea automation have led to inefficiency
  - Predictive models largely uncalibrated
  - Excess flow, fatigue, corrosion safety margins
  ➔ Increased cost, reduced reliability
- Automation key to driving down subsea costs
- Advances in wireless & battery technology enables step reduction in subsea automation costs
- Subsea Internet of Things moves analytics to the edge
- Subsea Cloud Computing leaves data at the seabed
- The prize: step reduction in CAPEX and OPEX
Thank you
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“The electric light did not come from the continuous improvement of candles” – (Oren Harari)