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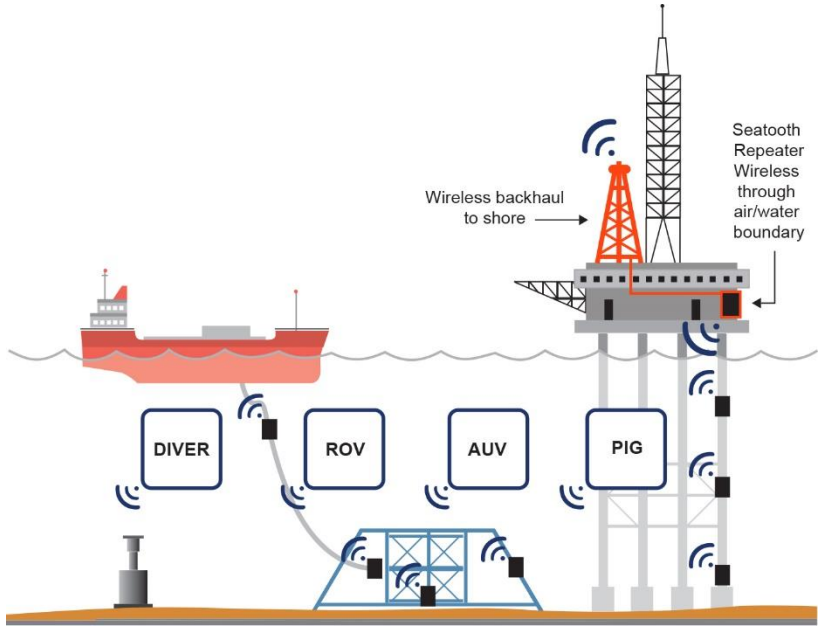
Subsea Internet of Things

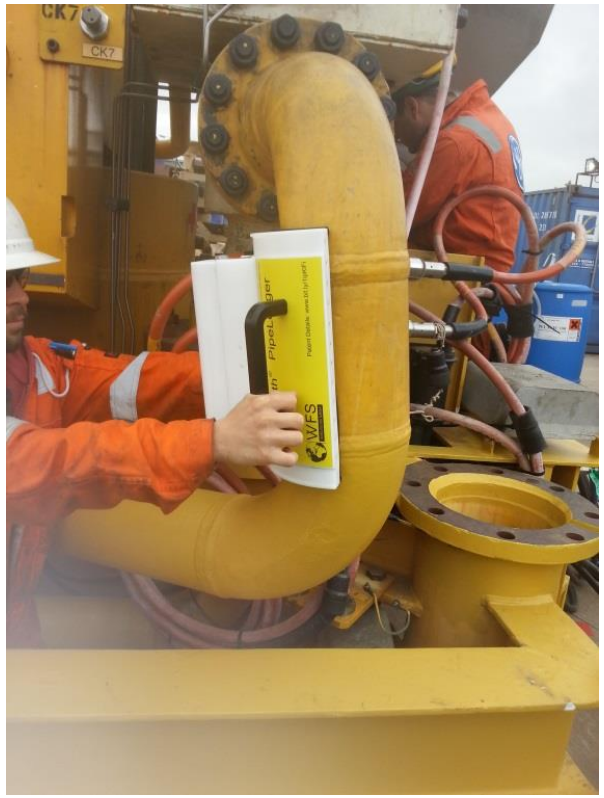


Brendan Hyland
WFS Technologies

Subsea Controls Down Under
October 2016

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

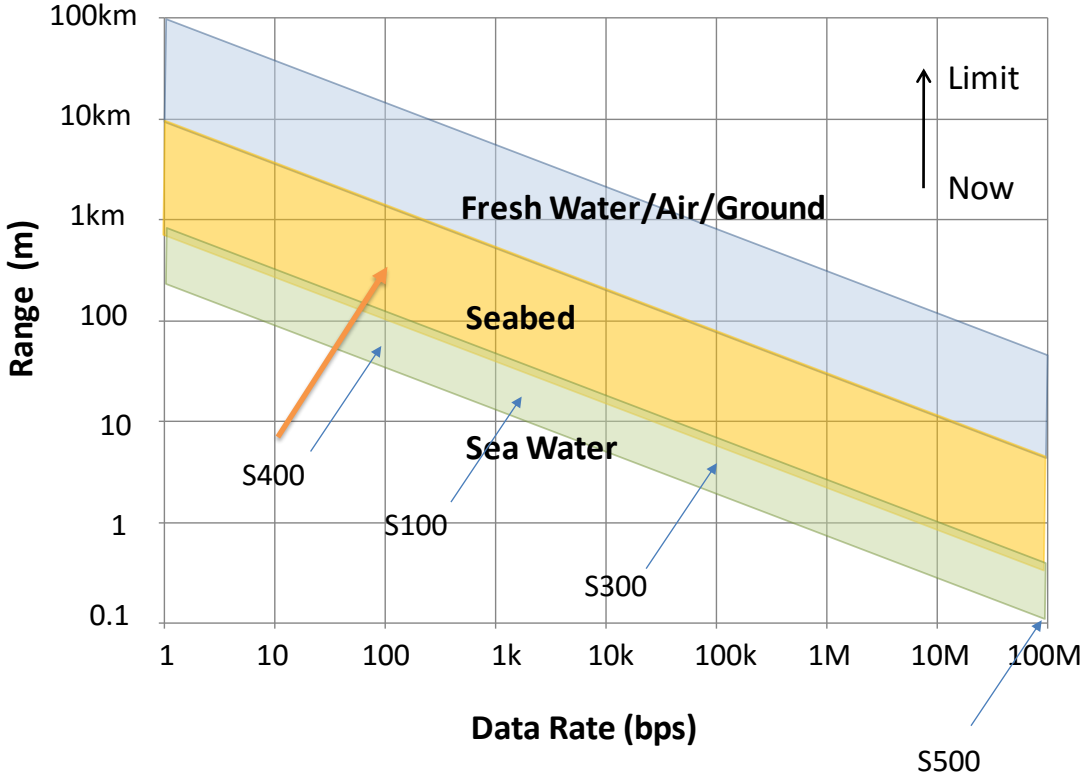
About WFS Technologies
- *Background*

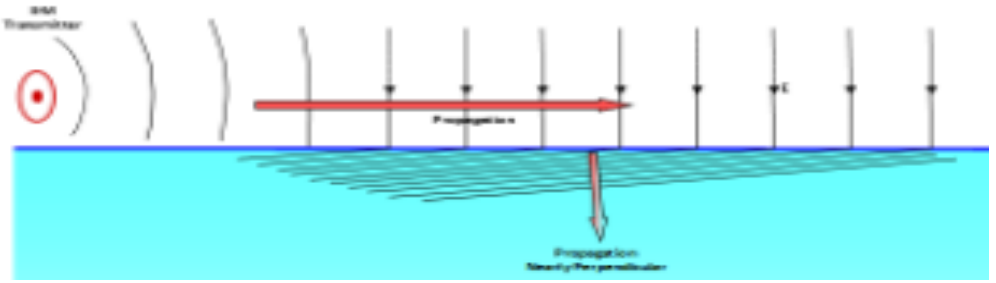
- Founded Edinburgh, Scotland in 2003
- Privately owned
- Head office Edinburgh, Scotland
    - Sales/Projects offices in Houston, Vietnam
- World leader in radio based subsea wireless automation
- Seatooth radio technology developed in-house
    - >200 man-years of research
- >7000 Seatooth products 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

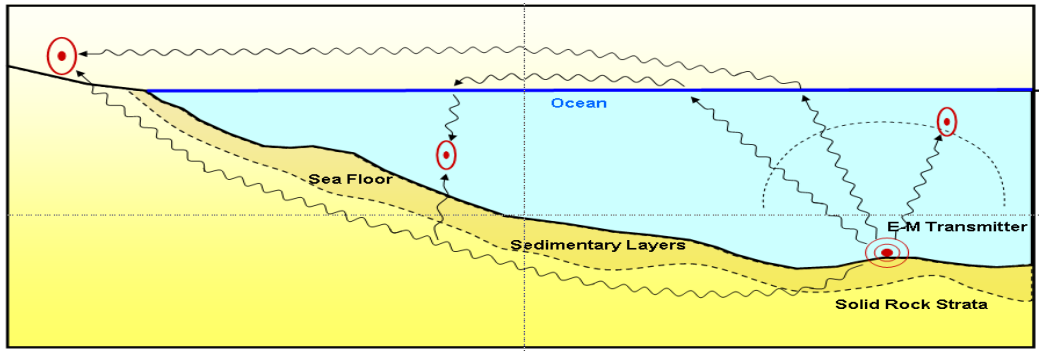
Seatooth Wireless Network

About WFS Technologies
- *Seatooth Technology*





Propagation through Water-Air Boundary



Radio finds path of least resistance

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

- Propagation loss through water/air boundary ≈3bB
- Unaffected by turbidity, biofouling, aeration, thermal layers, engine noise
- Ultra low power receive technology key to deployments of 10 years +

Seatooth Video

- Total, Laggan Tormore

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Subsea Wireless
- *Comparison of options*

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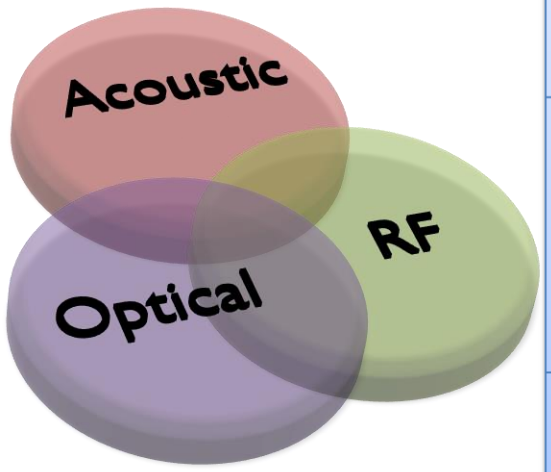
- Complementary wireless technologies
  - Acoustic
  - Radio
  - optical
- There is no 'silver bullet'
- Select technology that best matches application
- Future of subsea wireless is *Hybrid*



SWiG

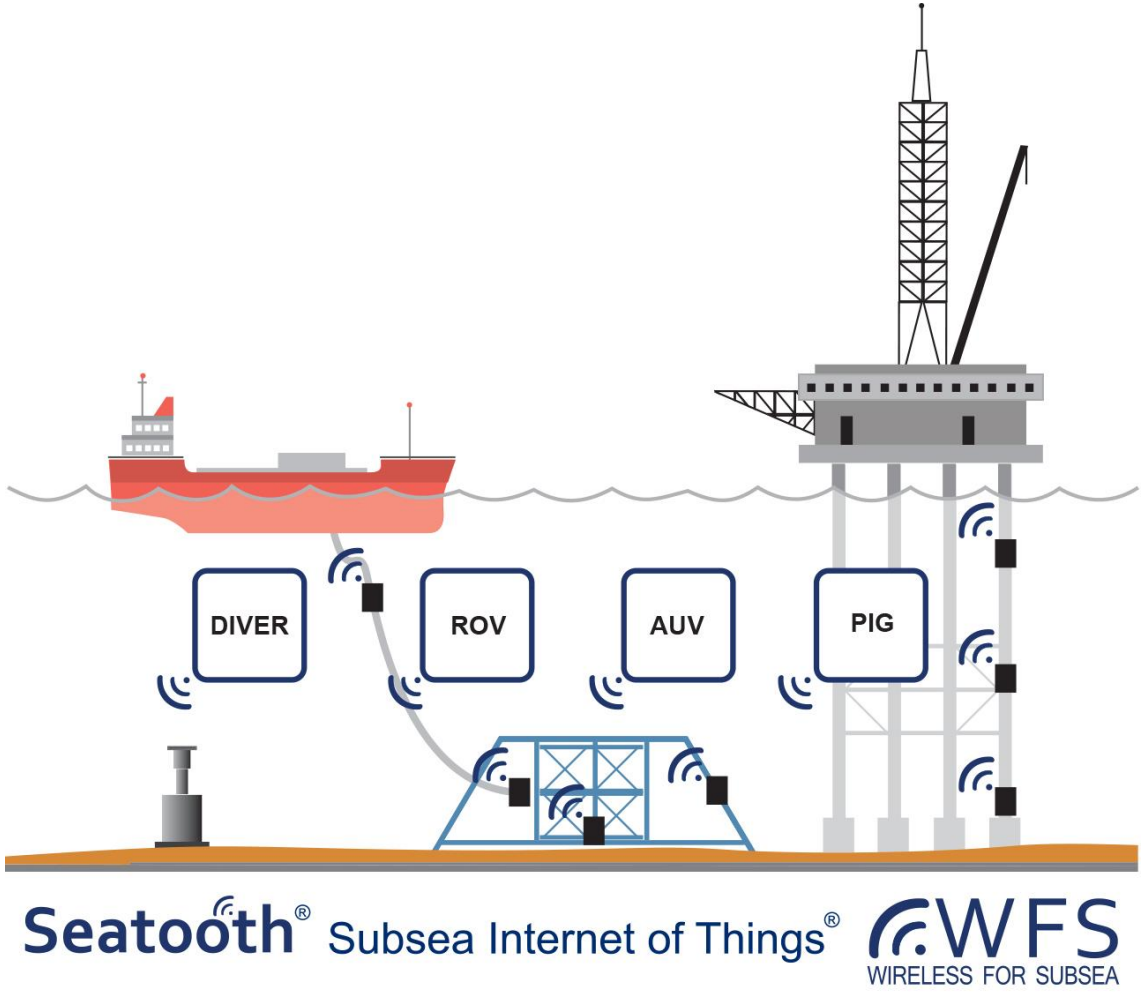
Subsea Wireless Group

	Pros	Cons
Acoustic	•Proven technology •Range: up to 20 km •Energy Efficiency at longer ranges •Precision navigation	•Adversely affected by - Water aeration - Ambient noise - Multi-path in shallow water •Unpredictable propagation •Limited bandwidth •High latency •Impact on marine life •Does not transit water/air
RF	•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 •Transits water/air & water/seabed	•Limited range through water •Low energy efficiency at longer ranges •Susceptible to in-band EMI
Free Space Optical	•Ultra-high bandwidth: Gbps •Compact •Low latency •Immune to acoustic & EMI noise	•Susceptible to turbidity & particles •Marine fouling on lens faces •Line-of-sight •Needs tight alignment •Short range •Difficulty transiting water/air

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*

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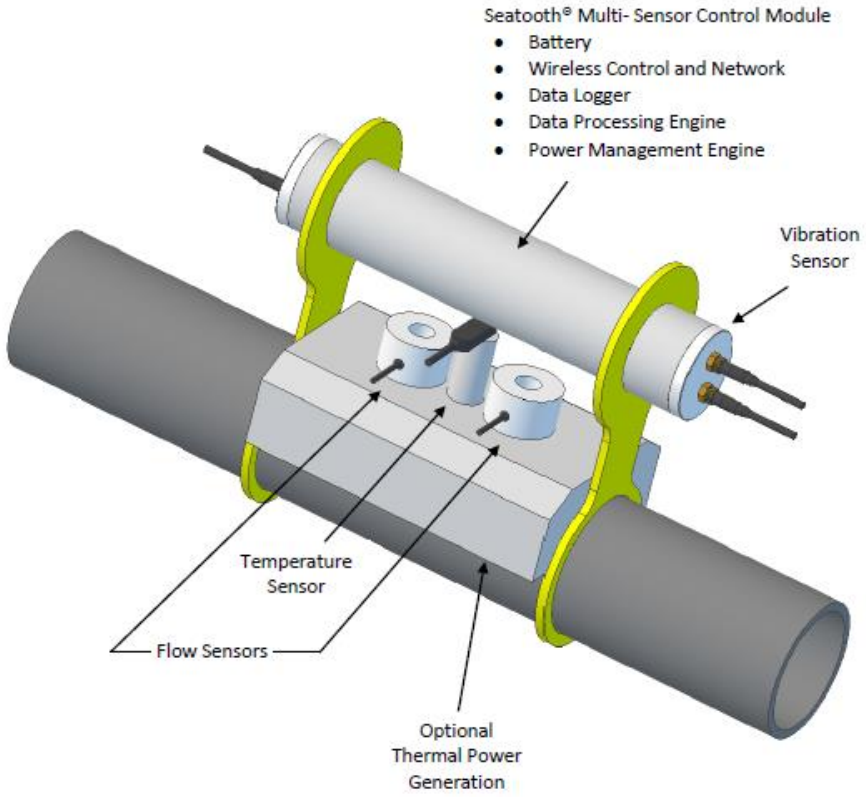
- Multi-parameter sensor
  - Asset Integrity: Temp, UT, CP, Vibration
  - Flow Assurance: Temp, Flow, Vibration
- Local data processing
- Local process model correction
- Intelligent power management
- Local power generation

Seatooth® Flow Assurance (FA) PipeLogger



What is the Subsea Internet of Things?
- *Wireless*

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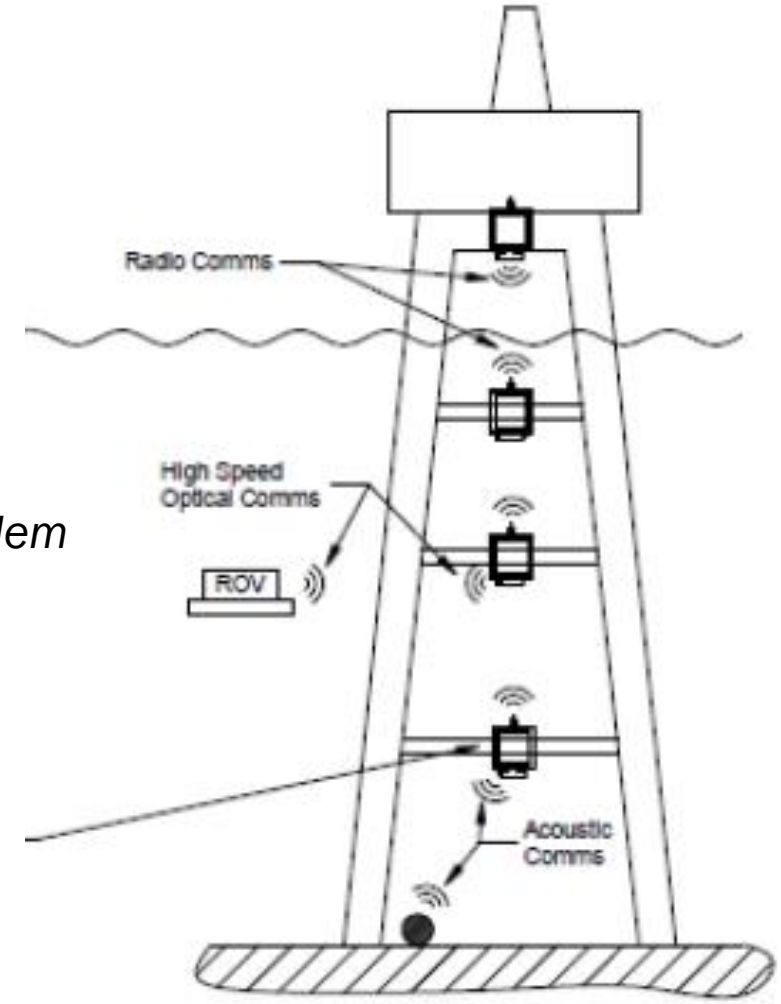
- *Wireless = Hybrid incorporating wireless*
  - Hard wired
    - Copper
    - Fibre optic
  - Wireless
    - Radio
    - Acoustic
    - Free space optics
- Select the most appropriate technology
  - Cost
  - Resilience
  - Performance
  - Flexibility

Subsea Umbilical

Seatooth Radio modem

Acoustic modem

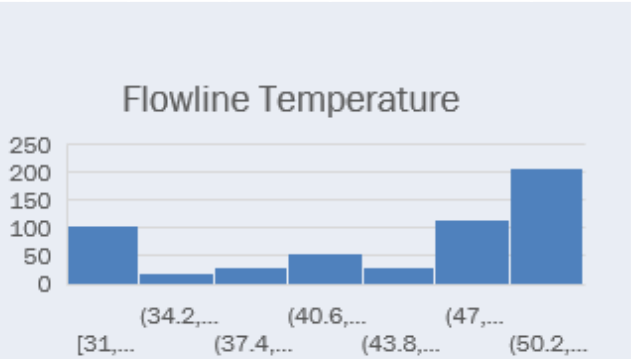


What is the Subsea Internet of Things?

- *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

Temperature	Date/Time
31	13:00:00
31	14:00:00
31	15:00:00
31	16:00:00
31	17:00:00
31	18:00:00
31	19:00:00
31	20:00:00
31	21:00:00
31	22:00:00
31	23:00:00
31	00:00:00
31	01:00:00
31	02:00:00
31	03:00:00
33	04:00:00



Convert data to Information

Subsea Internet of Things
- *Applications*

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- **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

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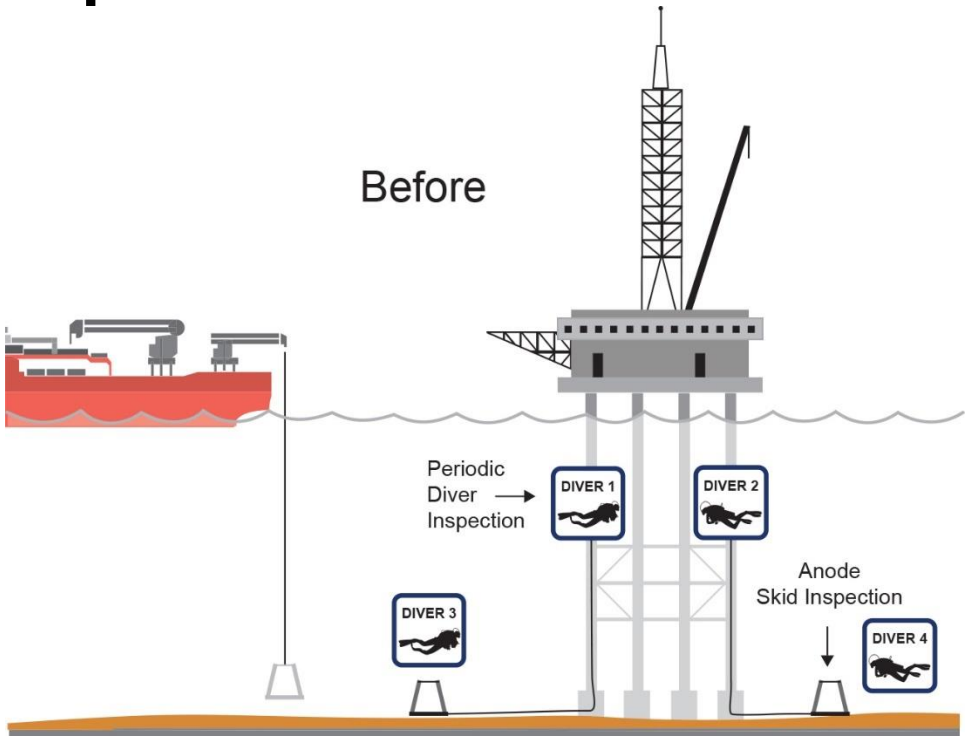
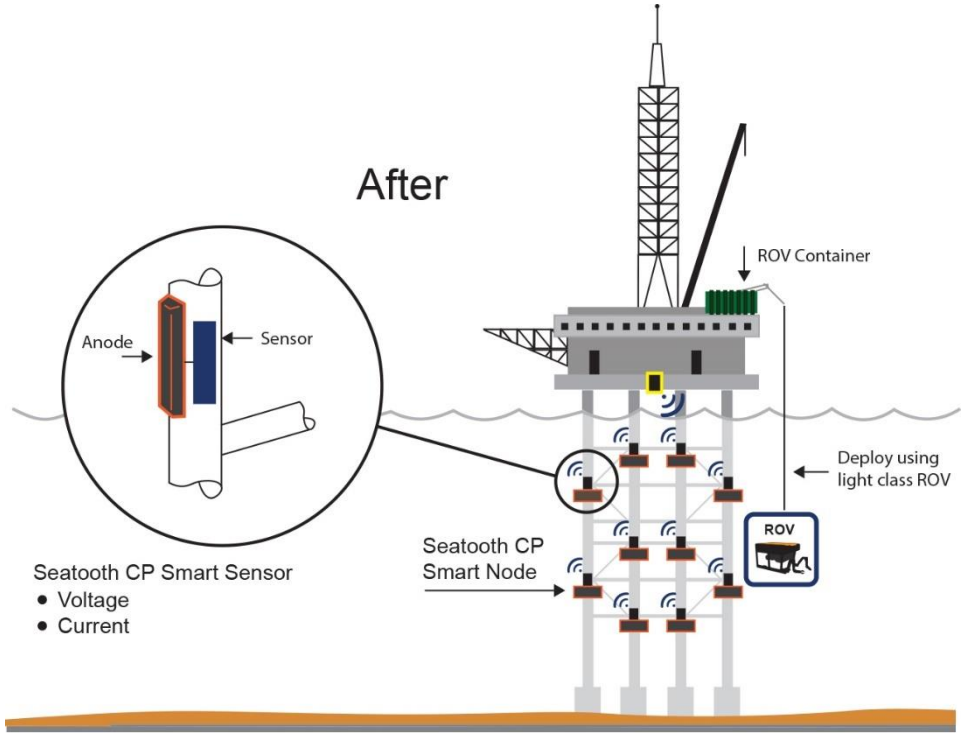
CP Inspection Automation





- Reduce inspection costs → extend interval between inspection
- Improve quality of information → location, timeliness, reliability, frequency
- Flexibility to extend sensor network → subsea wireless SCADA

Subsea Internet of Things

- Asset Integrity

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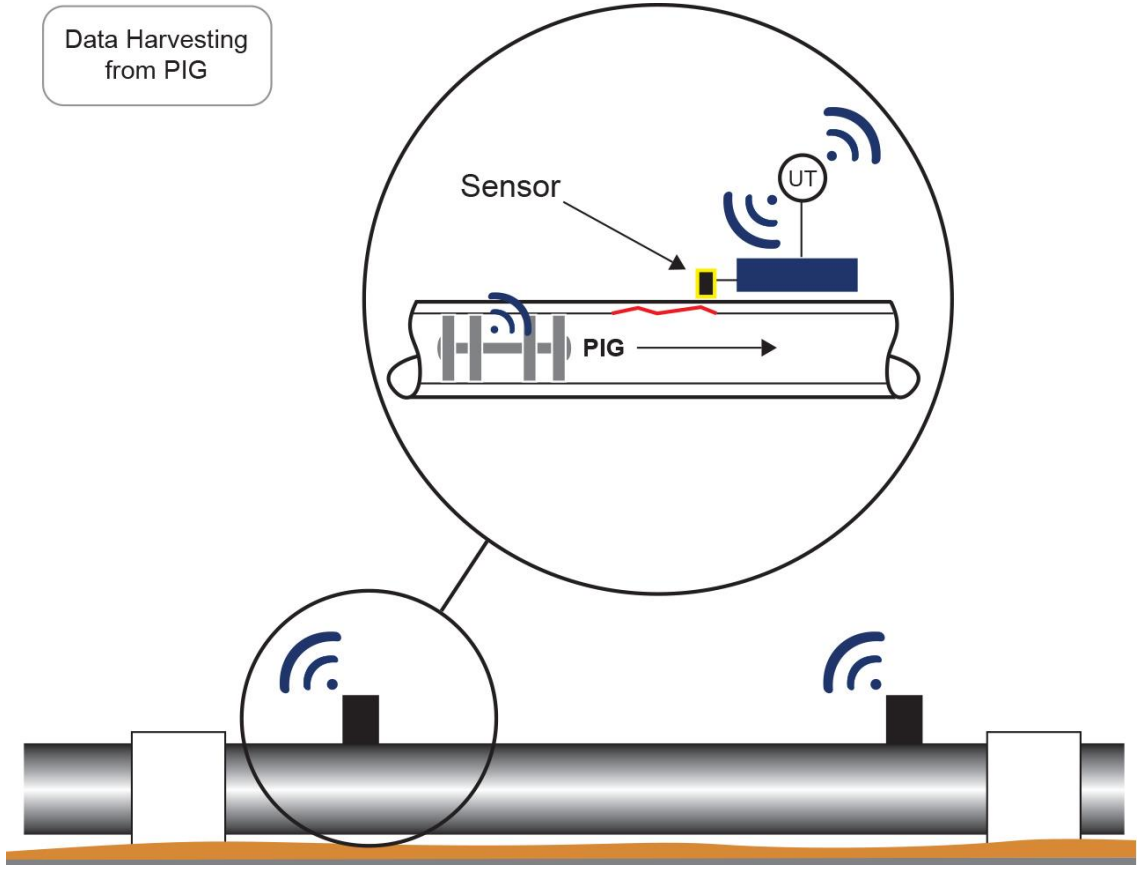
Pipeline Corrosion Monitoring with PIG

- 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

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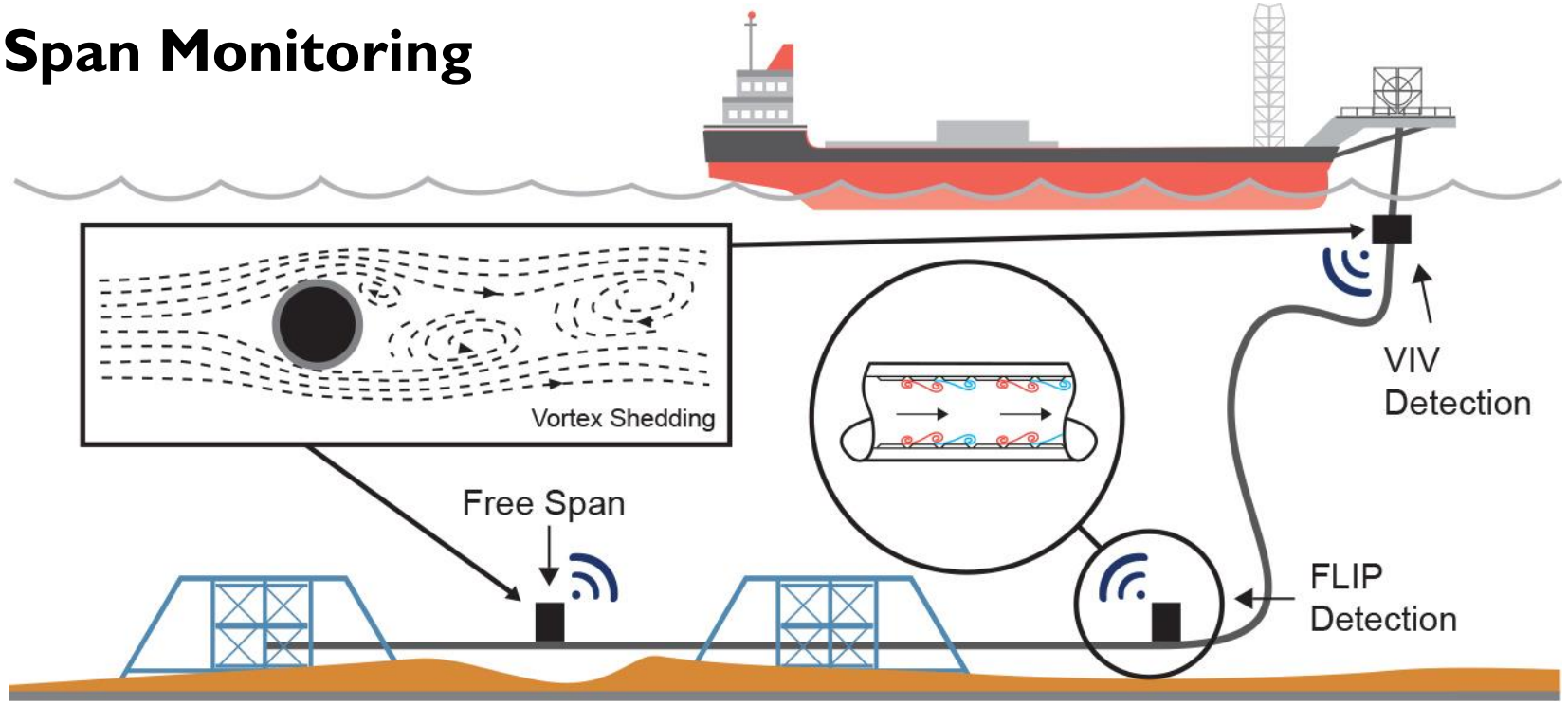
FIV/VIV/Free-Span Monitoring



- 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

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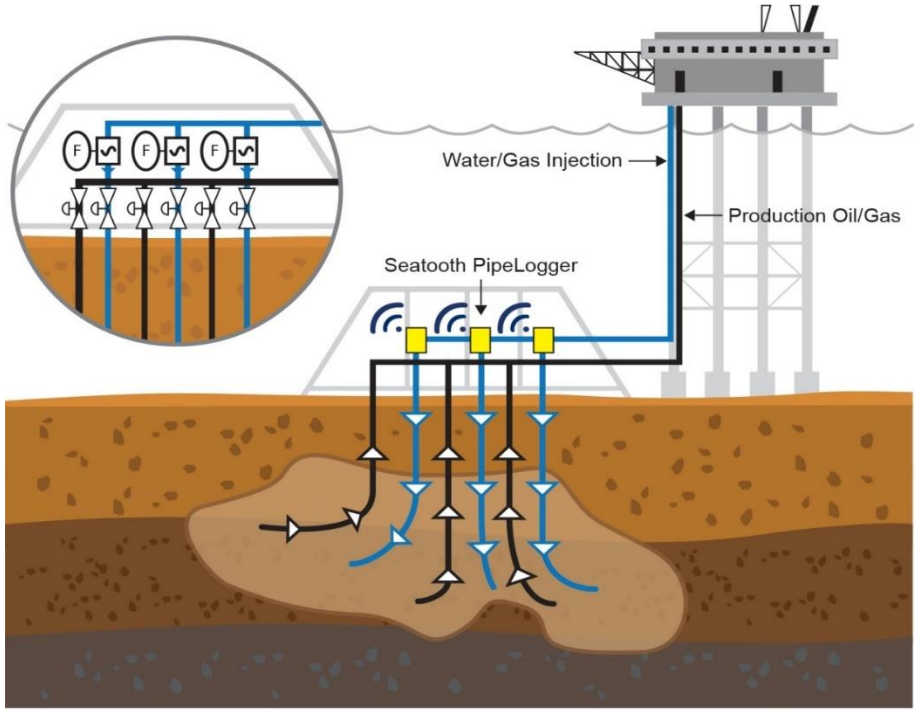
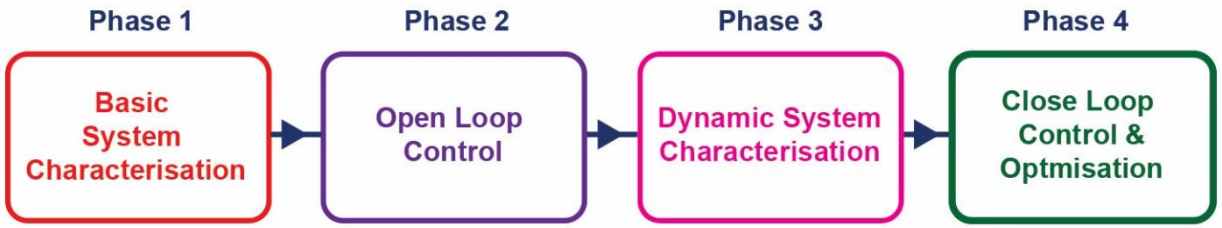
EOR Water/Gas Injection Control

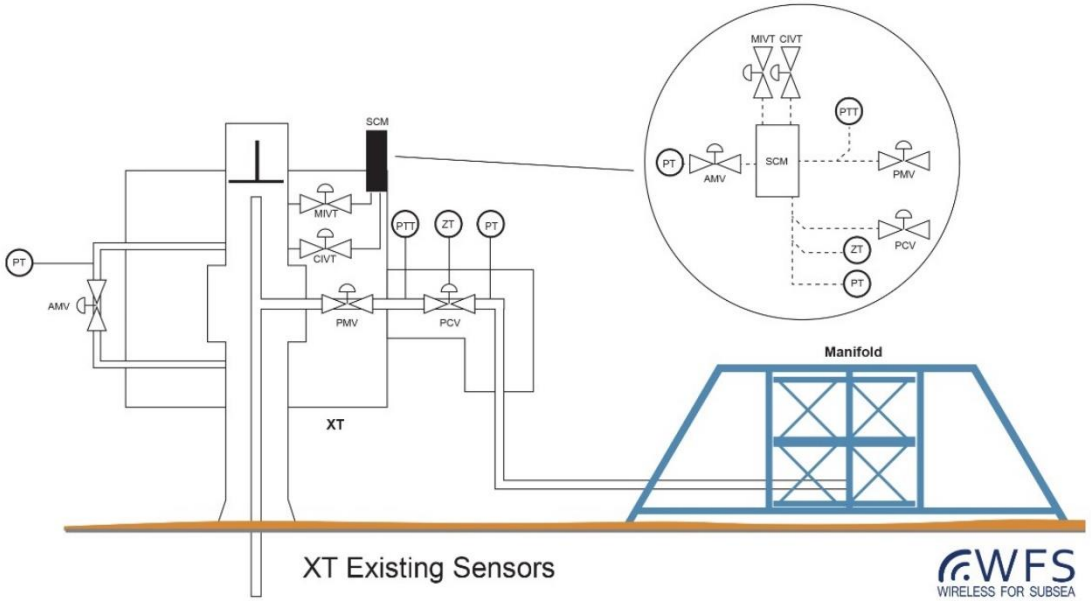
- Increase production
- Extend reservoir life
- Solution
  - Retrofit wireless network of smart flow meters
  - Implement control strategy

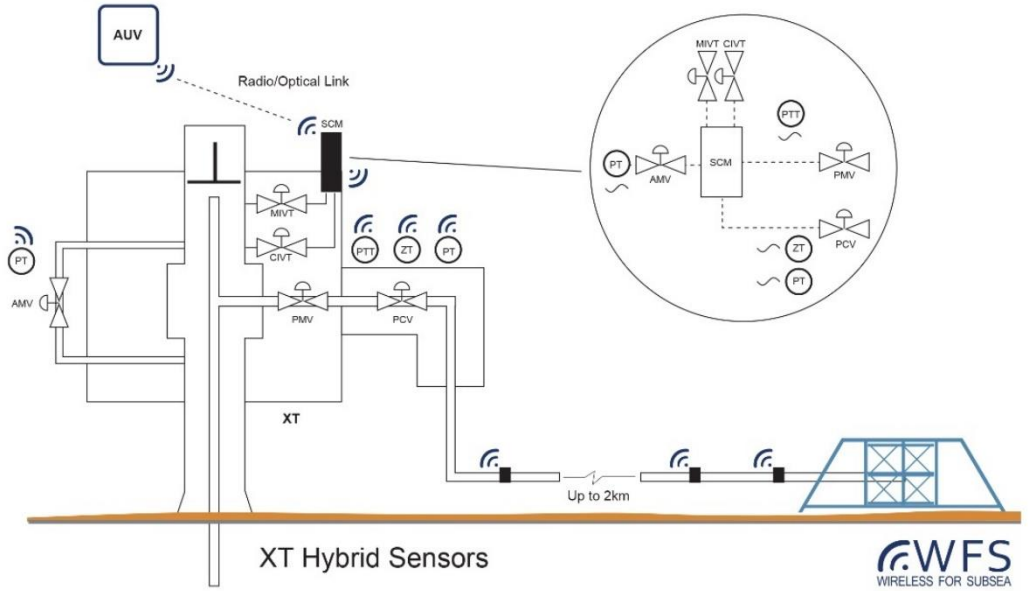




Subsea Internet of Things

- *Production Control*



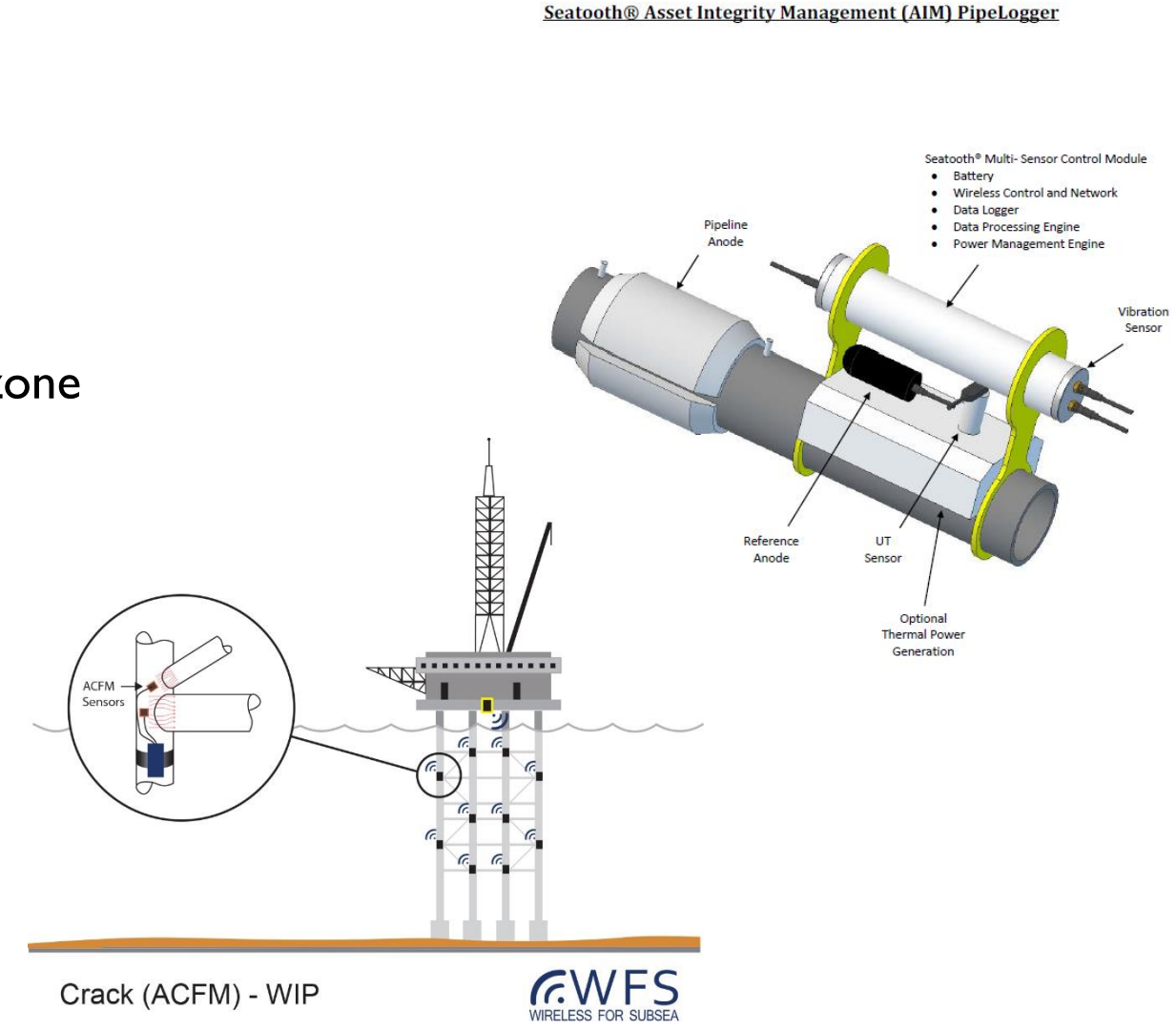


- Reduced CAPEX ➔ lower electrical load, reduced installation cost
- Increased reliability ➔ fewer connectors and jumpers
- Increased flexibility ➔ futureproof control system expansion

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



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Thank You

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