Asset Integrity Assurance and the Role of Autonomous Vehicles

Ross Doak & Lee Wilson
Shell & Subsea 7

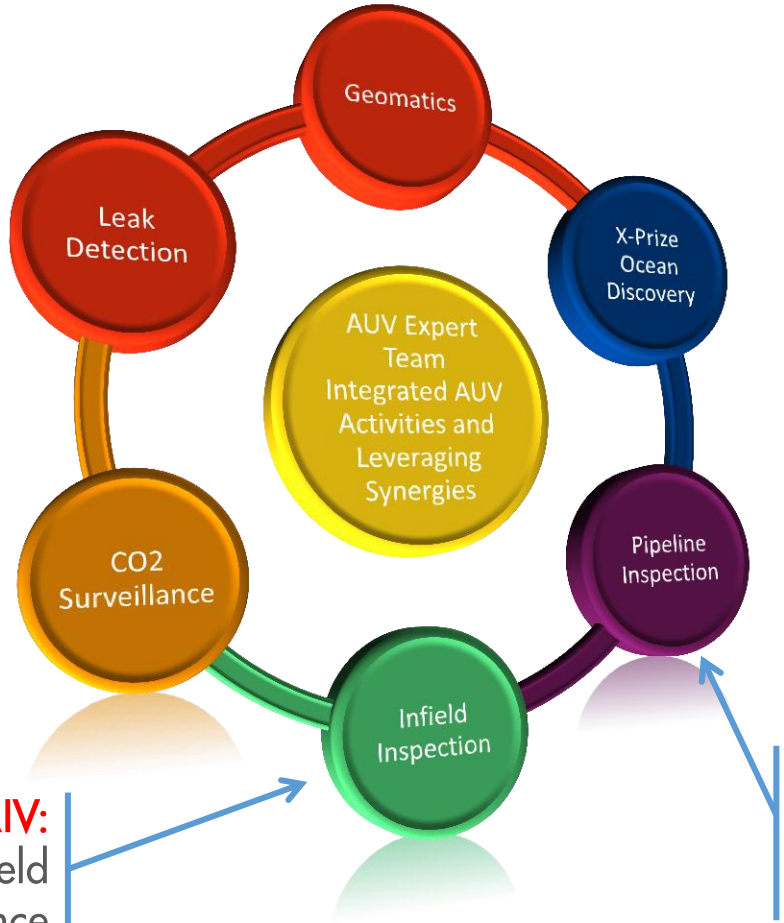
MAXIMISING FIELD VALUE THROUGH ASSET INTEGRITY

- Shell operates in 5 continents and has significant subsea infrastructure that requires routine inspection
  - Significant opportunities to improve operational expenditure
- Asset Integrity – A key part of maximising value drivers
  - Minimises risk to personnel, the environment and equipment
  - Assists production availability
- Shell looks to collaborate with others in bringing high potential technologies to the market to deliver cost reductions
  - AUVs – High potential to help realise the opportunity

AUV DEVELOPMENTS – A HOLISTIC APPROACH

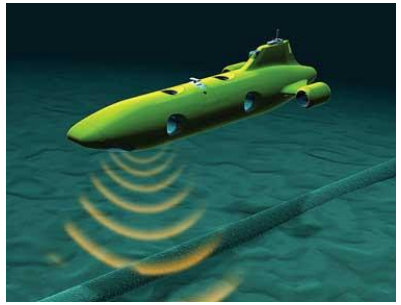
Shell Tech Works SPAM:
Integrated payload that delivers leak detection capability

Subsea 7's AIV:
Aims to deliver LoF cost reductions for Infield Subsea Surveillance



Shell OCEAN DISCOVERY XPRIZE

Shell X Prize:
Global competition to advance deep sea technologies for autonomous and high speed ocean exploration.



Torpedo AUVs:
Aims to deliver cost reductions in pipeline inspection

SHELL AND SUBSEA 7 – AIV COLLABORATION

- June 2013 – Shell and Subsea 7 collaboration began
  - Primary focus on improving Asset Integrity
- Goal of the Collaboration:
  - Deliver a new tool in the subsea inspection toolkit that can deliver more efficient ways of working and cost reduction.
- Key challenge:
  - To ensure the AIV can provide high quality data to allow for ongoing Asset Integrity Surveillance

MAXIMISING THE VALUE OF THE AIV – THE AIM

REDUCING COST	■ Maximising efficiency of vessel time in field ■ Reducing vessel requirements ■ Onshore inspection personnel
BETTER DATA	■ UHD Visual mosaic of subsea infrastructure ■ Leak "sniffing" capability ■ Integrated CP sensor
NEW APPROACH	■ Subsea hosted system ■ Light intervention without a vessel ■ Data mining from installed condition monitors

DELIVERING THE SAME DATA FOR LESS– THE CHALLENGE

- Key Challenge: Acquiring data without the human feedback loop
- Technology selection is crucial for both data quality and efficient operation
- Requires a new approach

UHD Photomosaic

- Ultra High definition
- Ensures complete coverage

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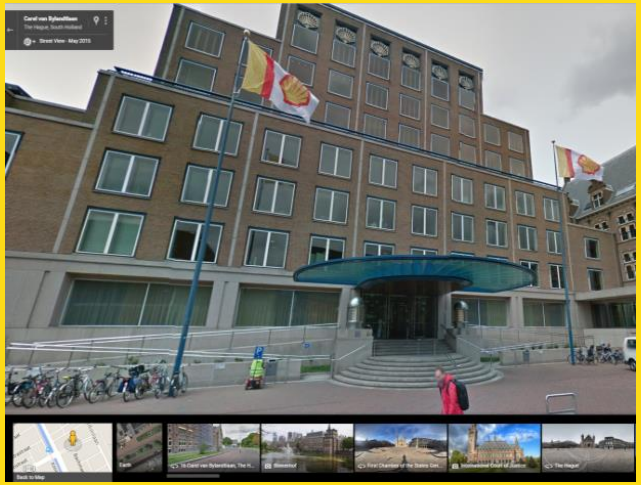
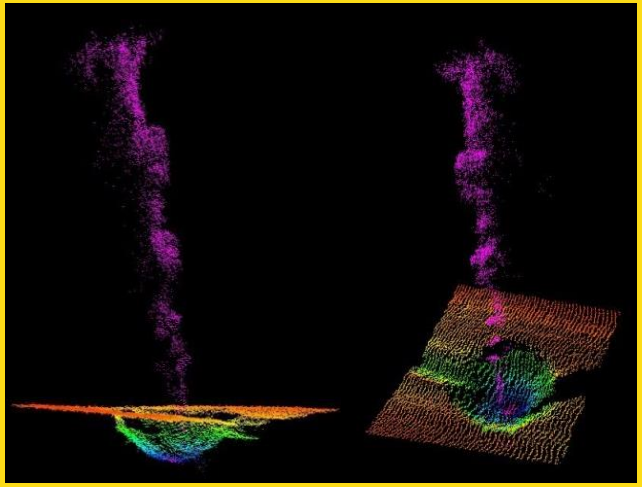


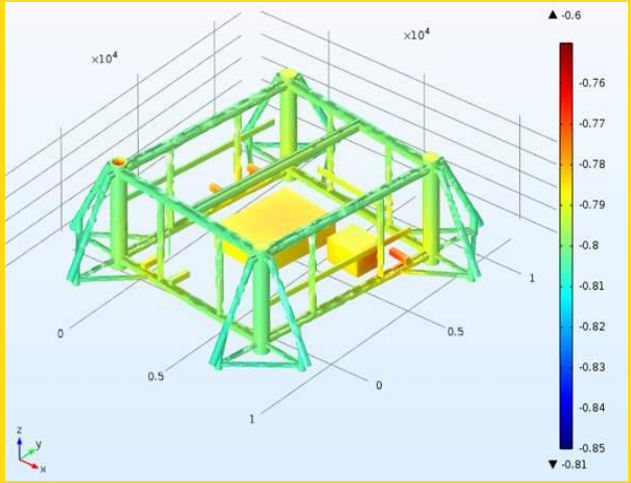
Leak Detection

- Refinement on ROV
- Key for stakeholders



Integrated Contactless CP

- Key part of Asset Integrity
- Novel Approach



REALISING THE FULL OPPORTUNITY - FUTURE DEVELOPMENTS

SUBSEA HOSTED SYSTEM

Key Challenges:

- System reliability
- Adaption – Greenfield vs. Brownfield

The Prize:

- Increased inspection capability
- Enabling safer under ice surveillance
- Rapid response capability

SEE, TOUCH AND DO

Key Challenges:

- NFC – Converging New Technology
- Tooling and Reliability

The Prize:

- Increased capability
- Reduced intervention costs

The AIV

3000m rated hover capable Inspection AUV

24 hour endurance, 40km round trip range

Enables proactive inspection strategies

Fundamental advantages over torpedo AUV

Key enabling technologies:

- Hover / Stop / Close Manoeuvring
- Feature Based Navigation
- Subsea Docking to Basket

Reduced vessel dependency

Basket Launch and Recovery is a phase shift for AUVs

Telerobotic or Semi Autonomous Control Options

subsea 7

Conventional AUV – High Vessel Dependency

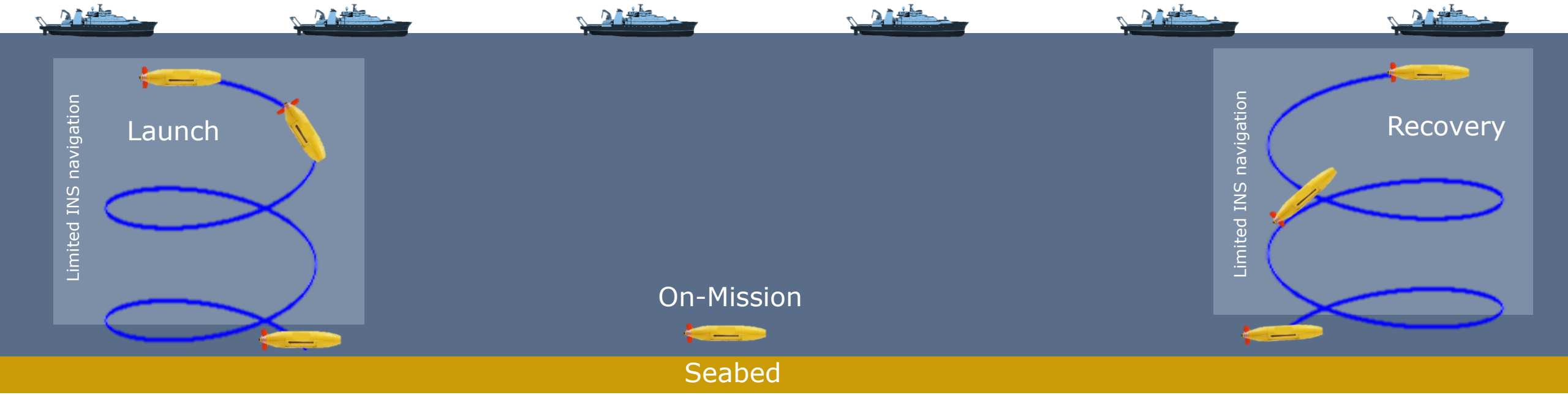
Establish Launch Location
Mission Start
Launch Overboard

Dive Monitoring
INS Updates
Seed Nav Position

In-mission Monitoring
Position Updates

Ascent Monitoring
INS Updates

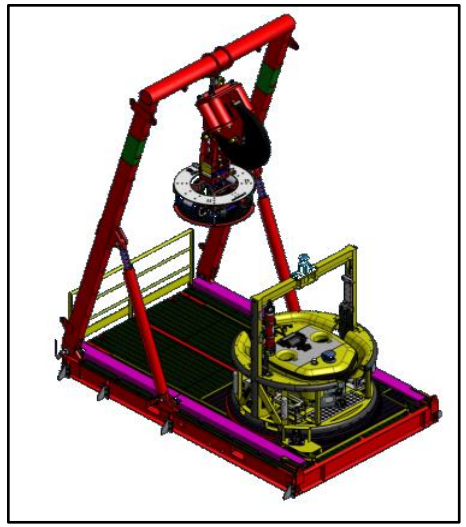
Connect to the Vehicle
Recover to Deck
Mission End



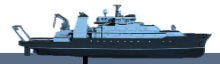
AIV - Low Vessel Dependency

Establish Launch Location
Deploy Basket
Seed Nav Position
Send Mission Start

Use vessel crane, or small footprint A-Frame system with remote latch



Pick Up Basket
Recover Basket to Deck



Limited INS navigation

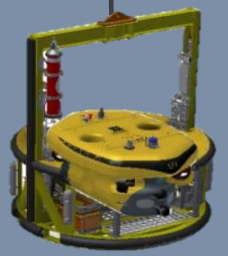
Launch

Mission Start
Leave Basket

On-Mission

Mission End
Dock in Basket
Await Recovery

Limited INS navigation

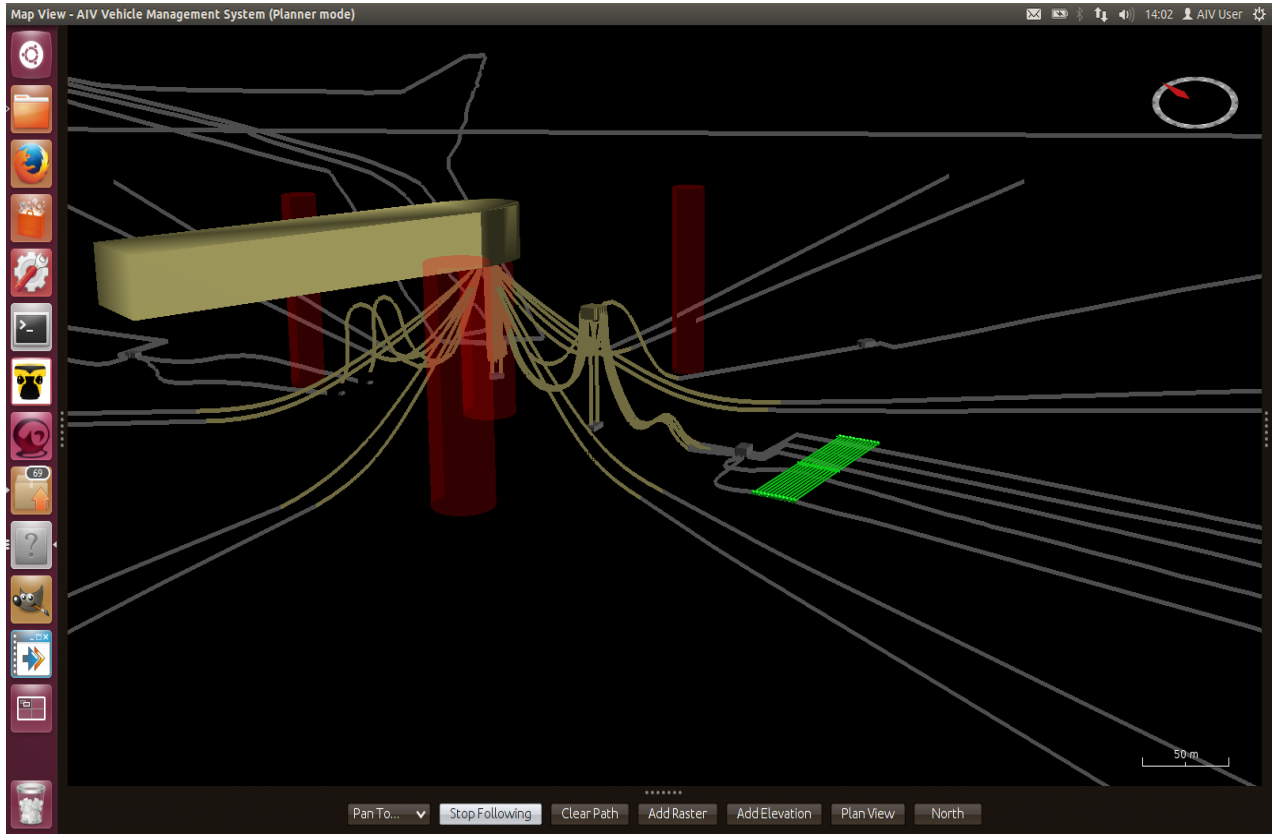


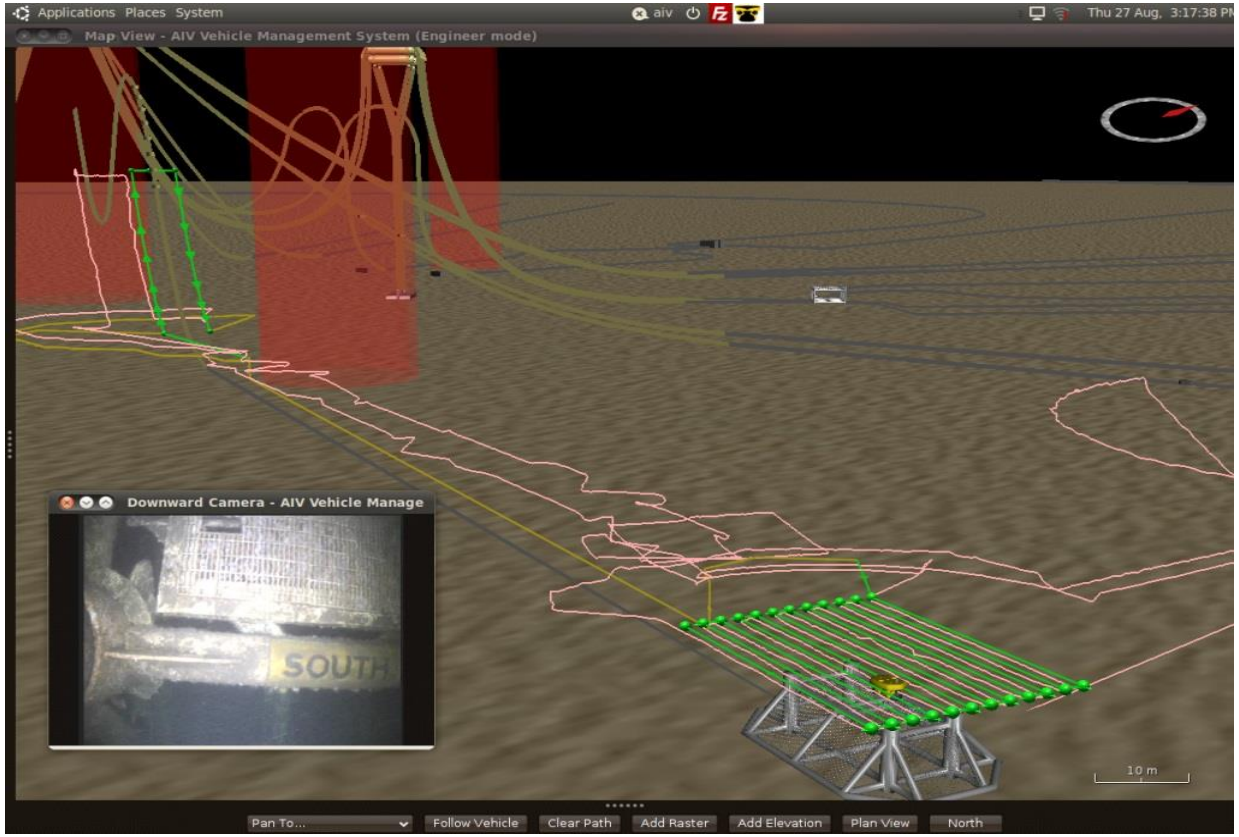
Recovery

Seabed

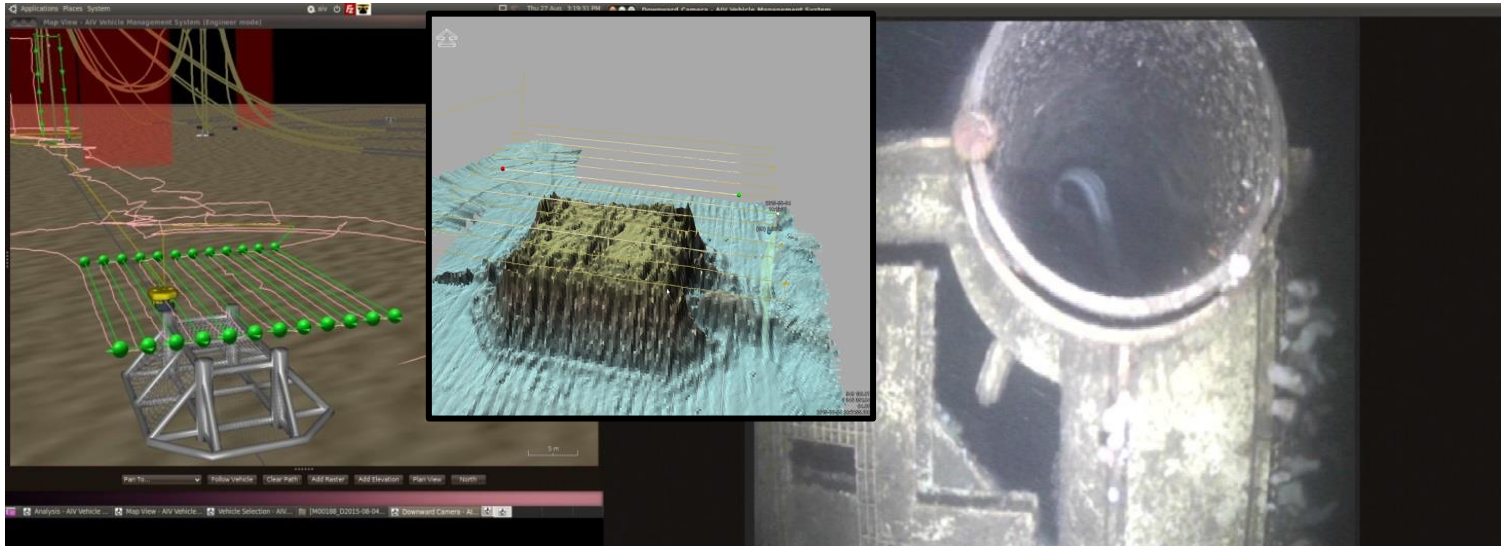
Navigating using a-priori knowledge

AIV navigates using a 3D model compiled from client supplied data. This same model is used for the onshore mission planning and can be updated as part of the service and data delivery.



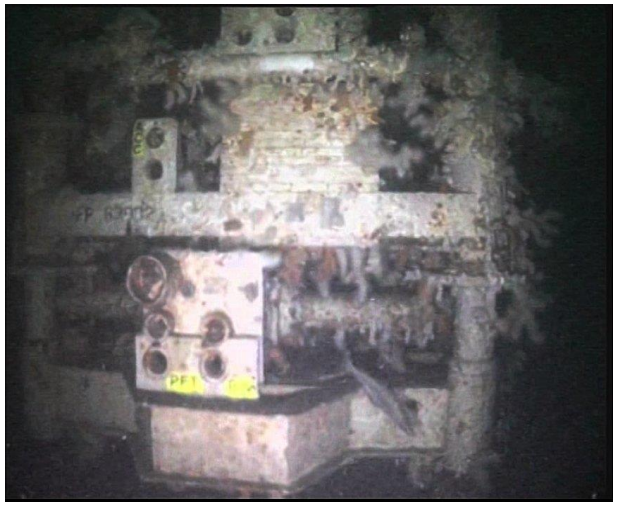


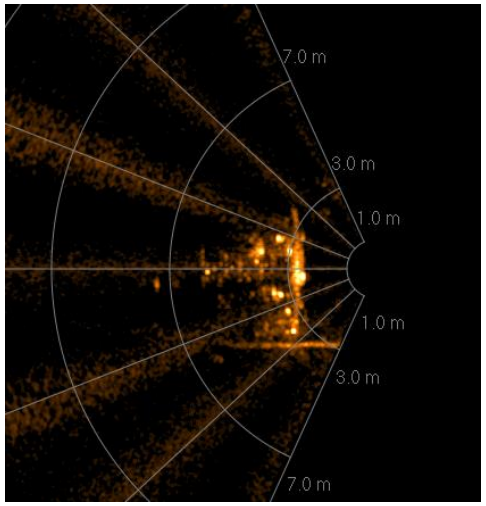
Facilities Inspection



Top Down Inspection

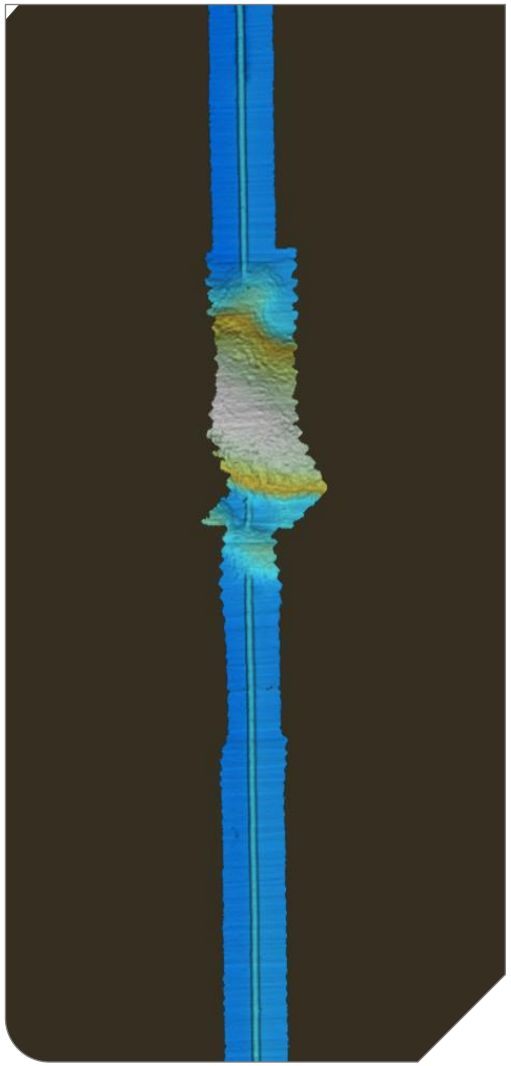
AIV identifies the correct structure in field using absolute position then re-orients relative to it. This ensures AIV is in the correct location to carry out the inspection.

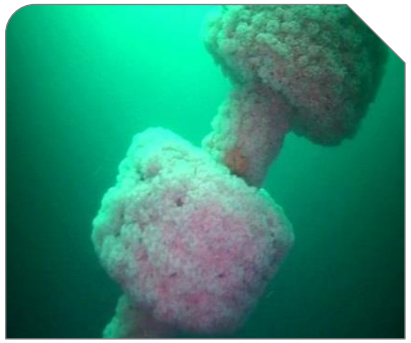


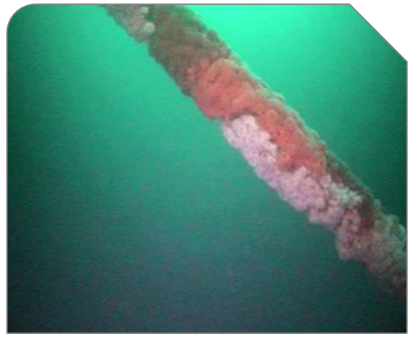


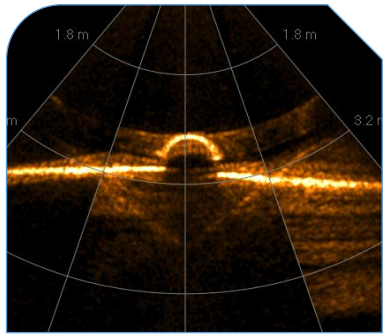
Side on Inspection

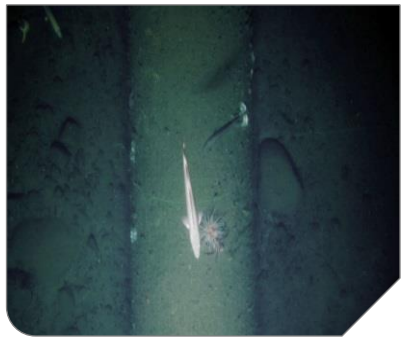
Riser and Pipeline Inspection











AIV locks-on to risers and pipelines using sonar.

It tracks at an optimum inspection distance of 1.5-3m

This ensures the inspection object is always in view.

Forward and downward looking imaging systems are used to gather visual and sonar imagery of the pipelines and risers.

Qualification Status

Planning and control systems fully developed.

Operational and safety behaviours fully implemented.

Over 20,000 hours of full missions in simulation, hardware in the loop.

Three offshore campaigns in 2014/2015, validated core capability. Over 300 hours offshore in-water time, real oilfield infrastructure.

Next phase scheduled Q2 2016 (inshore, UK), followed by full offshore FAT.

Unique “Flying Crane Latch” developed to extend launch and recovery options.

New sensor payloads in development.