Resident Unmanned Underwater Vehicles: AUV, ROVs and Hybrid AUV/ROV systems as mobile instrument platforms on Axial

NOVAE Workshop: New Technology Ideas
The Concept

• The concept of resident UUVs and mobile instrument platforms has always been connected to cabled ocean observatories.

• Cabled infrastructure provides the required power and high-bandwidth communication capabilities.

• Sampling and surveys that happen a few times a year would become routine weekly or daily events.

• Immediate availability - vehicles would be ready to monitor an eruption, or any other event, as soon as it happens.

• As technology progresses, resident vehicles can be remotely programmed to autonomously perform increasingly complex sampling tasks and to autonomously recognize events to investigate.
Some of what exists now

- ONC (NEPTUNE Canada) VPS profiler and Wally II crawler.
- RSN shallow and deep profilers.
- The Wally crawler remains a relative unique example of a successful long-term resident vehicle deployment.
- The OOI Pioneer Array is using Gliders and AUVs and they are actively working towards resident capabilities.
Possible Resident UUVs

- Gliders
- AUVs
- Crawlers
- Hovering Hybrid AUV/ROVs
Docking and “work” site placed near platform

Test platform with work space and hoist and lift facilities

Test area: 8-15 m deep Flat sand bottom

Harbour

400 m

Saab Sabertooth Demo
Oil & Gas push towards resident systems

- Oil & Gas companies see a lot of potential in residential hybrid AUV/ROV for integrated field support.
- Many companies such as Chevron and Tecnomare are actively working with industry to enable rapid development and to address the various technology gaps and challenges.
- Oil & Gas and manufacturers are now designing and testing long-term resident vehicles such as the SAAB Sabertooth.
- Many of the lessons learned and technology will be directly transferable to resident systems on cabled ocean observatories.
Saab Sabertooth

Specifications
• Can operate in full 6 Degrees of Freedom
• Depth rating 3,000 m
• Length 3.7 m Height .45 m Width 1.2 m
• Launch weight 1250 kg
• Forward speed 4 knots
• Thrust Forward 150 kgf Lateral 90 kgf Vertical 160 kgf
• Battery capacity 20 kWh (30 kWh option)
• Endurance 10-20 hours
• Range 50 km
• Payload 80 kg

Roadmap
• Auto Target Recognition
• Re-planning and Adaptive Mission Control
• Under Ice Applications
• Long Term Resident Application
Sabertooh Survey Demo

- Edgetech 2200 combined SSS and SBP
  - Simultaneous dual frequency SSS: 230/850 kHz
  - 2-16kHz chirp SBP
- BlueView M900-2250 (dual frequency, 900kHz and 2.25MHz), 130 degrees field of view imaging sonar
- Tritech parametric sub bottom profiler
- R2Sonic 2024 MBES with external SVP for SV compensation
- Phins III INS with RDI DVL
- AXIS industrial grade HD IP camera
- QINSy data logging
Resident Vehicle Operations?

- Starting in the docking station, the AUV will work through a queue of survey tasks, autonomously prioritizing activities based on task importance and battery life.

- Upon returning to the dock after completing a full duty cycle, that AUV will upload all of the inspection data (photographs, 3D models, CP readings, etc.) to the observatory where they can be automatically distributed.

- For more complex work that is beyond the autonomous capability of the vehicle, high-rate communication equipment could be installed within the field to allow a remote operator to wirelessly provide real-time command and control to the vehicle, essentially flying it like a traditional tethered ROV.
Some Ideas

• Data Harvesting
  • Sensors in remote areas which can then be autonomously visited by an AUV. Data could then be harvested and the sensor packaged recharged.

• Interchangeable payload
  • Beside the permanent sensors mounted on the vehicle. The docking station could allow for several “E-Pod” and tools to best suit the next mission.

• Interventions
  • As the technology advances, hybrid vehicles will be capable of performing light intervention work either while being remotely controlled by an on-shore operator or autonomously.

• Wireless stations
  • Wireless communication systems, such as BlueComm, could be placed in strategic places in the observatory to allow for remote control operations.

• Autonomous sensor use
  • Photo mosaic performed when event detected by one of the acoustic sensor.

• Floating Tether Crawler
A few of the challenges

• Reliability and Maintenance
  • Component reliability will be a central concern in the development of resident AUV systems.
  • To date, there has been little effort to prove the ability of AUVs to survive underwater for long periods of time.

• Docking Systems
  • Capability has been proven but long-term deployments remain to be proven and trials are just now getting underway.

• Availability
  • Systems needs to be ready to monitor an eruption event.

• Environment
• Failure modes
• Navigation
• Operations and data-management
First steps

• Establish the sampling/surveying requirements and their priorities.
  • No single UUV concept will meet all needs. System design must be driven by your sampling/surveying priorities.
  • Can the UUV adapt to changing priorities when Axial is (1) leading up to an eruption, (2) in an eruption, and (3) in the transition from eruption to post-eruption?

• Generate the specifications for the “ideal” UUV(s).

• Establish a plan to move forward towards integrating resident UUVs at Axial.