Deep Submergence Needs for Ocean Observatories

DESSC meeting - WHOI May 17-18, 2004

Deep submergence needs for ocean observatories have been addressed in two recent reports:

- 2003 NRC Report *"Enabling Ocean Research in the 21st Century - Implementation of a Network of Ocean Observatories"* (Detrick et al.)

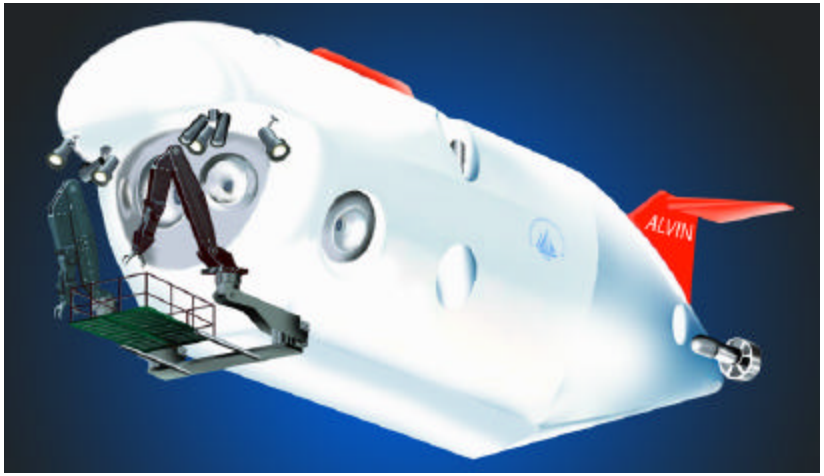
- 2003 UNOLS Working Group Report: *"Ocean Observatories Facilities Needs from UNOLS"* (Chave et al.)

⇒ Deep submergence assets will play a critical role in the installation, operation and maintenance of ocean observatories and associated science support operations

⇒ Both HOVs and AUVs will be able to perform important tasks at observatories, but ROVs are expected to be the “work-horses” of deep-sea observatories due to their:

- extended dive duration
- heavy-lift capability
- high available power

HOV



Role in ocean observatories:

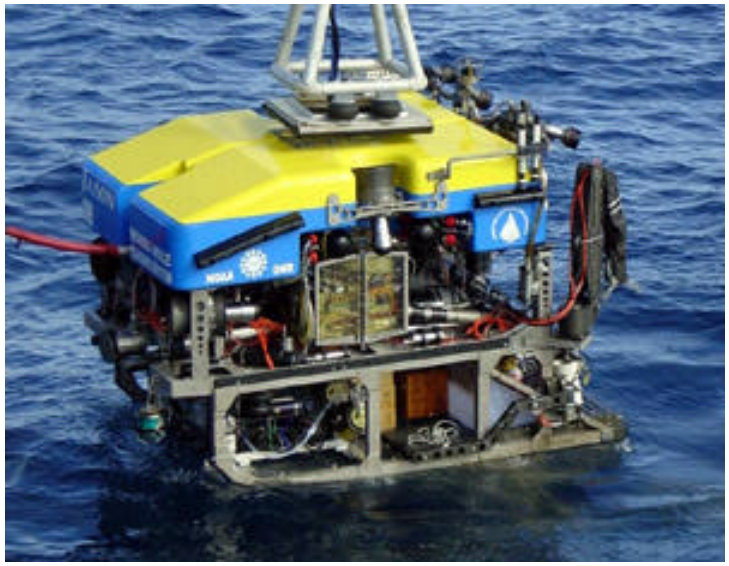
- Conduct scientific investigations (mapping, sampling) around proposed observatory sites prior to installation
- Install experiments and sensors in areas of complex topography (e.g. in a hydrothermal vent field)
- Perform servicing of some observatory sensors and instruments after installation or carry out experiments requiring unique capabilities of HOV

AUV

Role in ocean observatories:

- Used for high-resolution mapping for cable-route surveys
- Conduct high-resolution seafloor, geophysical or photographic mapping around an observatory node for scientific studies and to identify changes
- Conduct regular repeat surveys to determine variation in water column properties around a node
- Respond to transient events detected by monitoring observatory sensors

ROV



Role in ocean observatories:

- Specialized ROV for burial and post-lay inspection of cables
- Installation and servicing of seafloor junction boxes, deployment of ‘extension cables’
- Connection of moorings to seafloor junction boxes
- Servicing, repair or replacement of network equipment or instruments
- Deployment of long-term science experiments and general science support

ROV Requirements

(from Chave report, 2003)

- Deep ocean operation (to 6500m and beyond)
- Twin manipulators with at least one being a highly dexterous master/slave design
- Ability to accommodate on-board payloads of no less than 250 lbs water weight
- Adequate dynamic thrust to lift and move objects weighing up to 500 lbs in water
- Ability to lift of up to 2000 lbs to recover junction boxes and other equipment
- Ability to operate to Sea State 5, and preferably higher, for both NEPTUNE and the global buoy observatories
- Ability to carry diagnostic tools to troubleshoot nodes/associated equip. *in-situ*
- High precision real-time acoustic navigation
- Flexible power and data telemetry to accommodate a wide variety of sensors
- Ability to use a cable payout reel system for short (up to 10 km) near-bottom lays
- Fiber optic umbilical with dedicated spare fiber.

- Deployable from a variety of support vessels

=> Current generation of academic ROV, such as *Jason II*, are highly compatible with ocean observatory requirements

Available Non-Commercial Deep Submergence Assets (from Chave, 2003)

Vehicle	*Depth Limit (m)*	*Affiliation*
Jason II	6500	WHOI/NDSF
ROPOS	5000	Canada
Tiburon	4500	MBARI
Ventana	1850	MBARI
ATV	6000	SIO
Isis	6500	SOC
German ROV	4000	MARUM
Victor	6000	IFREMER

$\Rightarrow$ numerous commercial ROV systems available for applications up to 2500m depth; below 3000m the number of commercial systems decreases dramatically and only very small number operate in up to 6000m depth

Projected Observatory ROV Demand

Est. O&M requirements: ~ 600 ROV days/yr

⇒ A single, deep-ocean ROV, *Jason II*, available through the NDSF will not be adequate to meet both observatory and general expeditionary science requirements

⇒ *At least* two additional deep-ocean ROV are needed by 2010 to meet the projected demand from ocean observatories and still satisfy other science needs

Note: Projected observatory ROV operational requirements are strongly dependent on the number and location of nodes and the assumed service interval.

Issues for DESSC, UNOLS and ORION

- What is the most cost-effective mix of academic and commercial ROV for ocean observatories O&M? What capabilities should be given the highest priority for UNOLS-operated vehicles?
- What role will non-US ROV play in O&M of ocean observatories (e.g. Canada, others)?
- Should academic-operated ROV (or AUV) dedicated to observatory work be managed through NDSF? If so, what are the implications for how the NDSF is structured and operated in the future?
- What design criteria will need to be established for observatory nodes and future vehicles to allow ROV (and HOV) operations around nodes with surface or sub-surface moorings?

Estimates of Observatory Ship/ROV Requirements

Observatory Type	Specifics	Number of Nodes	Ship type	Ship-months	Comments
Global Moorings	Installation Low-bandwidth	1 node/10 sites	UNOLS Global class	10 (one time)	ROV not needed if acoustically-linked
Global Moorings	Installation High-bandwidth	1 node/5 sites	Industry charter (1 leg) UNOLS (1 leg)	10 (one time)	ROV needed for installation of junction box/seafloor sensors
Global Cable Re-use	Installation Minor move	1 node/at 5 sites	UNOLS Global class	5 (one time)	ROV needed for installation of junction box/seafloor sensors
Global Mooring or cabled	Maintenance High-bandwidth/ Severe envir.	10	UNOLS Global class	10/yr	ROV required for servicing or installation of seafloor sensors
Global Moorings	Maintenance Mid-lat./Tropical	10	UNOLS Global or Ocean class	10/yr	ROV not required for acoustically-linked moorings
Regional cabled	Installation of backbone cable loops	-	Two Industry Cable Laying	5 (one time)	Assumes 3700 km of cable (12% buried)
Regional cabled	Installation of Nodes/Core Sensors	30	UNOLS Global class	8 (one time)	ROV needed; probably would be done over 2 field seasons
Regional cabled	Maintenance backbone cable	-	Industry Cable Laying	0.5/yr	Stand-by maintenance contract with industry
Regional	Maintenance Nodes & Sensors	30	UNOLS Global or Ocean class	4-8/yr	ROV needed; work may be limited to May-Sept in NE Pacific
Coastal Moorings	Installation	75	UNOLS Regional	5 (one time)	2 Pioneer Arrays; ROV not required
Coastal Cable	Installation	1-2	Cable Laying	2 (one time)	Assumes one cabled observatory
Coastal Moorings	Annual Maintenance	75	UNOLS Regional/Local	5/yr	2 Pioneer Array; ROV not required
Coastal cable	Annual maintenance	<5	UNOLS Regional/Local	1/yr	Divers or ROV in deeper water