Interacting with the Oceans
For Research and Education

Kendra Daly
Director, ORION Program

Design & Implementation Workshop
Salt Lake City, March 27-30 2006
Monday, 27 March – Outline of Talks

• OOI/ORION and Goals of D&I Workshop
  Kendra Daly (ORION Program Director)

• OOI Budget and Timeline; RFA Review
  Alex Isern (NSF)

• STAC Process for Developing Conceptual Network Design (CND)
  Doug Luther (Univ. of Hawaii)

• STAC Coastal CND
  John Trowbridge (WHOI)

• STAC RCO CND
  Deb Kelley (UW)

• STAC Global CND
  Uwe Send (SIO)
Monday, 27 March

• ORION Cyberinfrastructure Requirements  
  Larry Mayer (Univ. of New Hampshire)

• ORION Education and Public Outreach  
  George Matsumoto (MBARI)

• Charge to Breakout Groups  
  Bob Detrick (WHOI) & Oscar Schofield (Rutgers)

• Questions
Outline

- Goals of the D & I Workshop
- History of the OOI and the ORION Program
- Components of the OOI
- ORION organization
- Timeline, Science Planning
Goals of the D&I Workshop

- Present the Conceptual Network Design
- Obtain comments and recommendations on the Conceptual Network Design
- Start to form collaborative groups for integrated research projects
History of the Ocean Observatories Initiative (OOI)

- Ocean observatories have been advocated since 1988
- OOI planning for ~ 10 years
- > 30 workshops, written reports, and planning documents have been produced
- NSF’s contribution to the national Integrated Ocean Observing System (IOOS) & to the international Global Earth Observation System of Systems (GEOSS)
### Observatory and OOI Milestones

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
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<tbody>
<tr>
<td>1998</td>
<td>National Oceanographic Partnership Program (NOPP) funds U.S. NEPTUNE feasibility study</td>
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<td>1999</td>
<td>Canada's Institute for Pacific Ocean Science and Technology invited by U.S. to undertake feasibility study of Canadian partnership with U.S. NEPTUNE</td>
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<tr>
<td>2000</td>
<td>OOI MRE Approved by the National Science Board at NSF <em>Illuminating the Hidden Planet</em> (National Research Council Report)</td>
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<td></td>
<td>NSF funds development of RCO communications system</td>
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<td></td>
<td>DEOS Moored Buoy Design Study</td>
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<tr>
<td></td>
<td>Sensor Technology for Remote Interactive Experiments in Aquatic Environments</td>
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<td>2001</td>
<td>NSF funds development of RCO power system</td>
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<td>2001</td>
<td>Ocean Sciences at the New Millennium Report</td>
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<td>2002</td>
<td>Victoria Experimental Network Under the Sea (VENUS) test bed funded by Canada Foundation for Innovation (CFI)</td>
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<tr>
<td></td>
<td>NOPP funds NEPTUNE system engineering</td>
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<td></td>
<td>NSF funds the Monterey Accelerated Research System (MARS) cabled-observatory test bed in Monterey Bay</td>
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<td></td>
<td>NSF funds development of cabled-observatory communications system</td>
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<td></td>
<td>Coastal Ocean Processes &amp; Observatories Workshop</td>
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<td>Scientific Cabled Observatories for Time-Series (SCOTS)</td>
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<td>2003</td>
<td>Canada Foundation for Innovation and British Columbia Knowledge Development Fund announce CAN$62.4 million in funding to University of Victoria for NEPTUNE Canada</td>
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- *Enabling Ocean Research in the 21st Century* (NRC Report)
- REgional Cabled Observatory Network (of Networks) (RECONN)
- Autonomous and Lagrangian Platforms and Sensors (ALPS)
- Implementation Plan for the DEOS Global Network of Moored-Buoy Observatories
- Biological and Chemical Instrumentation in the Ocean Workshop
- Links between OOI and IODP Workshop
- Coastal Observatory Research Arrays (CORA): A Framework for Implementation Planning
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<td>2004</td>
<td>Ocean Research Interactive Observatory Networks (ORION) San Juan Workshop – scientific and educational priorities using ocean observatories</td>
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<td>2005</td>
<td>OOI Science Plan</td>
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<td>May</td>
<td>RFA Community Proposals - proposals solicited to develop a baseline design for OOI infrastructure, including nodes locations and capabilities that should be available at experimental nodes.</td>
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<tr>
<td></td>
<td>48 proposals received</td>
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<tr>
<td></td>
<td>549 individuals</td>
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<tr>
<td></td>
<td>137 academic institutions, gov’t labs, and industries</td>
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<tr>
<td></td>
<td>from 35 states, 4 Canadian Provinces, Japan &amp; France</td>
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<td>2005</td>
<td><strong>May</strong> ORION advisory committee members prepare draft Conceptual Network Design</td>
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<td>2005</td>
<td><strong>Sept</strong> NSF-Panel review of RFA proposals</td>
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<tr>
<td>2005</td>
<td><strong>Oct</strong> NEPTUNE Canada signs contract for $39M with Alcatel to design, manufacture and install northern portion of the RCO</td>
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<td>2006</td>
<td><strong>Oct</strong> ORION advisory committee members complete draft Conceptual Network Design</td>
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*ORION advisory committee members prepare draft Conceptual Network Design*
> 85 people on the ORION Advisory Committees
### Observatory and OOI Milestones

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**ORION Design & Implementation Workshop, Salt Lake City**

**DESIGN & IMPLEMENTATION WORKSHOP**

Salt Lake City, Utah 27-30 March 2006 Marriott Downtown

Come to the ORION Design Workshop to provide input to the final design of the Ocean Observatories Initiative infrastructure.

This workshop will present to the ocean research community the preliminary design of the global, regional, and coastal ocean research observatory networks to be implemented under the ORION Program. The preliminary design is being developed based on the ideas submitted in the Request for Assistance Proposals, previous workshop reports, and advice from ORION’s scientific, technical, and engineering advisory committees.

The workshop will also provide an opportunity for collaborative groups to begin developing integrated research projects. This effort will lead to the realization of the Ocean Observatories Initiative, the National Science Foundation’s ambitious plan to develop and deploy observatory infrastructure in the oceans to enable novel research and expand educational opportunities. We strongly encourage participation in implementing these community facilities.

**CORE**  **NSF**  **JGI**

For more information visit the ORION website: [www.orionprogram.org](http://www.orionprogram.org) or contact: orion@oceanobservatories.org

Partial travel funds will be available for eligible participants. Early registration will be available on the ORION website in early December 2005.
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<td>2006</td>
<td>OOI recommended as a new MRE start in President’s FY07 budget. VENUS cabled-testbed installed in Saanich Inlet. <a href="http://www.venus.uvic.ca/">http://www.venus.uvic.ca/</a></td>
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Neptune Canada awarded an additional $8M from the Canada Foundation for Innovation towards adding an additional 4 science nodes.
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<th>Year</th>
<th>Milestone</th>
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<td>2006</td>
<td>MARS to be installed later this year</td>
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</table>
The range of processes that ORION intends to measure with sensors and instrument systems

- Air-sea interactions
- Physical
- Chemical
- Biological
- Geological
ORION is committed to three OOI components

- Coastal observatories
- Regional observatory (Pacific NW)
- Global observatories

INTEGRATION of components through Cyberinfrastructure
**Endurance Arrays** – Fixed, permanent observing array arranged as cross-shelf lines and individual moorings, some supported by fiber optic cable

**Pioneer Arrays** – Relocatable arrays for process-oriented studies
Regional Cabled Observatory

- Primary cable and nodes
- Secondary cable and nodes
- Vertical profiling moorings
Global Array

- Acoustically-linked discus buoy
- EOM cable-linked discus buoy
- Spar buoy
The Future of Computing in the Sciences

Bill Gates
Chairman and Chief Software Architect
Microsoft Corporation

Supercomputing ’05 Conference
Vision For Scientific Workflow

Example: Project NEPTUNE

http://www.neptune.washington.edu/

Bill Gates 2005
Programmable Sensors & Remote Instruments

Undersea Sensor Network

Connected & Controllable Over the Internet

Bill Gates 2005
Models are important to

- Integrate multi-scale, interdisciplinary observations,
- Formulate and test hypotheses, and
- Inform scientists on sampling strategies.

Pacific basin-scale ROMS: (1520 x 1088 x 30)

- 12.5-km horizontal resolutions & 30 vertical layers
- 50-year (1950-2000) integration

SST plotted in shade relief format
D. Haidvogel (Rutgers) & Y. Chao (JPL)
Characteristics of ORION Observatories

- Globally distributed
- Integrated network of sensing systems
- Near-real time data return and control
- Two-way communication to allow adaptive sampling

- Long time-series across many spatial scales
- Investigate short-term episodic events
- Multi-disciplinary approach to study complex natural systems and non-linear processes
- Open data policy
- Complex models for analysis and prediction
Characteristics of ORION Observatories (cont.)

The OOI is expected to be a 30 year facility

- Open to anyone (single PI or groups of PIs)
- Examples of science experiments in San Juan Report, OOI Science Plan, etc.

Planning for future innovation

- Modular
- Adaptable
- Expandable
- Interoperable
Expanded Coastal Observatory
Seafloor Geophysical Observatory with Seismometers and a Variety of Geodetic Instruments
Forest of vertical profiling moorings and borehole observatories
CORK Borehole Observatories

- 5 pressure gauges: 4 monitoring zones + seafloor reference
- 4 osmo samplers: one for each 1/8” line connected to each monitoring zone
- 1 dedicated microbial line from deepest interval

- wireline retrievable plug
- reentry cone
- seafloor depth
- ~ 50 mbsf
- sediment
- cemented in casing
- rubble zone
- basalt
- competent oceanic crust
- 2600 m
- 375 mbsf
- 275 mbsf
- 875 mbsf

- thermistor string
- umbilical containing
  - 1 packer inflation line
  - 4 pressure monitoring lines
  - 4 water sampling lines 1
  - 1 inert microbial sampling line

- packers
- pressure monitoring
- osmo water sampling

- osmo sampler & microbial experiments
Array of Genomic Sensors Sampling an Episodic Event

From Ginger Armbrust
Bacteria
Plankton
Retrieving Samples for Validation and Archival
Fiber Optic Cable
Robotic Arm
Lights
Chemistry/Biology Lab
HD Stereo Cameras
Imaging Sonar
Expanded Global Buoy
Seabirds as platforms for sensors

Image from Tremblay, Shaffer & Costa
Implementing Organizations

• The Implementing Organizations (IOs) will manage the procurement and installation of the observatory networks leading to the operation of these facilities for the ORION Program

• An IO may be an academic institution, a consortia of academic institutions, or an academic-industry partnership

• Separate IOs may be chosen for the coastal, RCO and global components of the OOI, as well as Cyberinfrastructure
Science Planning: OOI Timeline 2007-2013

2008
Phase I coastal and global observatories deployed
→ Need science experiments ready to start in 2008/9

2012
Phase II coastal and global deployments completed

2013
RCO finish testing and commission

***Start Science Planning - Suggestions for Workshops***
Imagination is the beginning of creation. You imagine what you desire, you will what you imagine and at last you create what you will.

George Bernard Shaw
What’s next?

**2006**

May - Advisory committee reviews revised CND based on the D&I Workshop comments

August - NSF Conceptual Network Design Review

**2007**

Spring – Final design review
Coastal first stage commissioned in 2008; need science experiments ready to start