Coastal and Global Scale Nodes

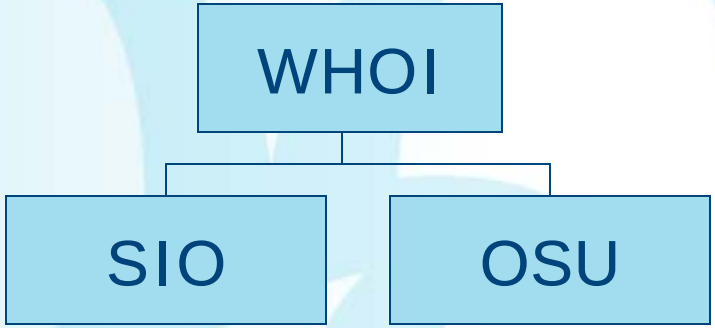
Woods Hole Oceanographic Institution
Oregon State University
Scripps Institution of Oceanography
Raytheon, Integrated Defense Systems Group

OCEAN OBSERVATORIES INITIATIVE

Preliminary Design Review
Dec 4-7, 2007

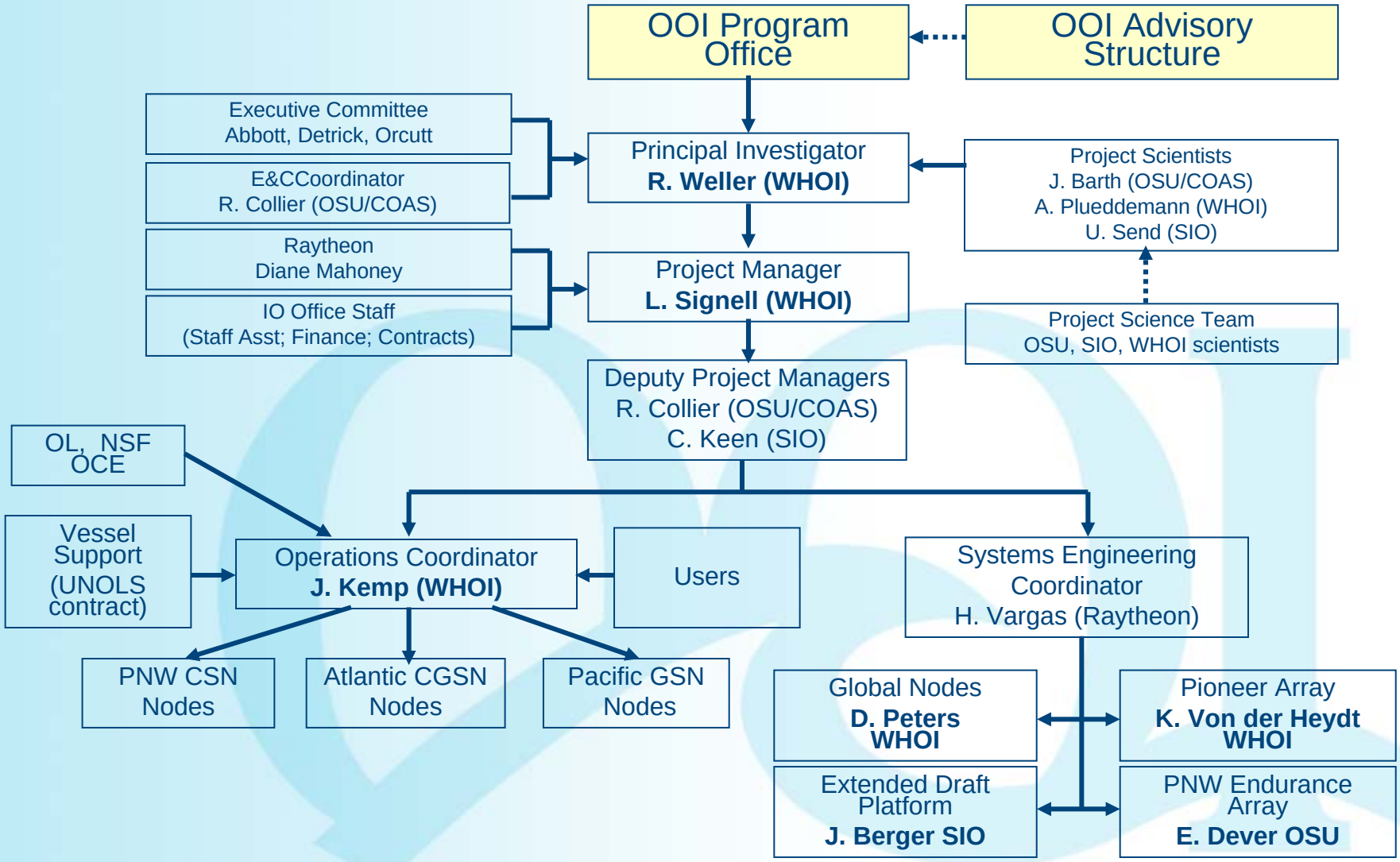
CGSN Implementing Organization

- WHOI is the Lead Institution
- Subawards to Partners SIO and OSU



WHOI is the CGSN interface to OL

CGSN Organization



Bold = Key Personnel

CGSN Engineering Organization

OOI Program Director
Holly Given

OOI CGSN COTR
James Christman

Principal Investigator - **Weller**

Program Management – **Signell** with Deputies Keen (SIO), Collier (OSU)

		Peters	**Von der Heydt**	**Dever**
	Systems Engineers			
	Project Science Advisor	Send	Plueddemann	Barth
ME CDT	Buoy	Carroll	Carroll	Waldorf
	Mooring	Trask / Kemp	Trask / Kemp	Waldorf
	Profilers	SIO	Subcontract	Subcontract
	Benthic Nodes	NA	McDonald/Faluotico	Waldorf
EE CDT	Mooring Control	Ware	Ware	Ware
	Power	Petitt	Petitt	Petitt / OSU
	Telemetry	Petitt	Koski	Koski
	Sensor Integration	Ware	Liberatore	Liberatore
OPS CDT	Survey	Subcontract	Plueddemann	Collier / Barth
	Permitting	Signell	Signell	Collier
	Installation	**Kemp**	**Kemp**	Waldorf
	O&M	**Kemp**	**Kemp**	Waldorf
	CI Interface	Maffei/SIO	Maffei/SIO	Maffei/SIO
	Data Management	Galbraith	Galbraith	Galbraith
		Global Sites IDT	**Pioneer Array IDT**	**PNW Endurance Array - IDT**

Extended Draft Platform (EDP)
Up-scope
Systems Engineer
Berger

Key Personnel

- Bob Weller, Project Director/PI
  - 30+ years experience – science, moored instrumentation
  - 35+ research cruises
- Libby Signell, Project Manager
  - 20+ years experience – engineering, project management
- John Kemp, Operations Manager
  - 30+ years experience – mooring design and development, at-sea operations
- Ed Dever, Systems Engineer PNW Endurance Array
  - 12 years experience – science, moored oceanographic observations
  - 20 mooring deployment/recovery cruises
- Don Peters, Systems Engineer Global Sites
  - 14 years experience – engineering, engineering leadership
- Keith von der Heydt, Systems Engineer Pioneer Array
  - 35+ years experience – engineering, engineering leadership
- Jon Berger, Systems Engineer Extended Draft Platform
  - Geophysical instrumentation and Seismological Data Analysis
  - Design and Implementation of 40 remote stations on Global Seismological Network

Budget

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Budgeting Process

- Bottom-up estimates in WBS
- CGSN Cost Book generated
- Resource-loaded IMS created in MSProject
  - Defined predecessor and successor tasks
  - Estimated task durations
  - Loaded resources from CGSN Cost Book
- Resources and time-phasing exported to OOI Access Cost Book

Contingency Rationale

- WBS 1.3.1 PM
  - Technical Risk NA.
  - Cost Risk Factor 6 - processes required by the CGSN Project are unfamiliar to WHOI, SIO and OSU. This risk factor was considered to impact labor only.
  - Schedule Risk Factor 8 was selected because PM issues impact the completion of the systems and therefore pose a high level of schedule risk .
- WBS 1.3.2 SE
  - Technical Risk NA. Systems Engineering risk process related than specific technology driven.
  - Cost Risk Factor 6 - Systems Engineers are new to the process. This risk factor was considered to impact labor only because the tasks are not specific to technologies or materials.
  - Schedule Risk Factor 8 was selected because SE issues impact completion of the entire system and therefore pose a high level of schedule risk.

Contingency Rationale

- Global AL Moorings 1.3.3, 1.3.4.1
  - Technical Risk 3 (6 for Southern Ocean due to power generation) -
    - WHOI experienced with the Nootka mooring.
    - Mesoscale Flanking Mooring is simple and not considered risky.
    - Winched profiler exists in prototype form. Assumed winched profiler development funding would be provided directly to winched profiler developers that NSF and OL consider promising for this application. Some development $ are allocated in our proposed budget but given the state of the designs presented at the Profiler Workshop 7/10-12, the planned funding is insufficient to provide the long term, open ocean testing necessary for confidence in these systems.
    - Technical risks are limited to design because manufacturing processes for these systems are well understood.
  - Cost Risk Factor 6.
    - Nootka was considered a related design. Cost Risk Percentage was set at Material costs well developed; more risk in labor cost.
  - Schedule Risk Factor 8.
    - Phased commissioning for Global AL Moorings.
    - Schedule slip at one site should not impact overall CGSN Project schedule should be recoverable.

Contingency Rationale

- PNW Endurance Array 1.3.3 and 1.3.4.2
  - Technical Risk Factor 3. WHOI and OSU have experience with similar moorings so they are generally well understood. One exception is the cabled portion, however, by subcontracting the RSN IO, we plan to use the solutions they develop thus avoiding a double-count of technical risk. A second exception is the winched profiler where we expect other funding to be available directly to the winched profiler developers to support their work in parallel with the CGSN Project. The Profiler Workshop (7/10-12) presentations made it clear that long duration shallow water testing of promising systems is necessary to provide reliable systems to CGSN. The Risk Percentage reflects the uncertainty in both the labor and manufacturing for the cabled portion of the PNW Endurance Array.
  - Cost Risk Factor 4. Mooring designs are well known and the cabled portions will be subcontracted to the RSN. The Risk Percentage is based on uncertainty in material costs associated with the cabled portion (subcontract).
  - Schedule Risk Factor 8. Un-cabled portions of the system could be installed first while the cabled portions will be among the last items deployed – the RSN schedule poses a risk to /GSN but the CGSN schedule does not impact the RSN schedule.

Contingency Rationale

- Pioneer Array 1.3.3, 1.3.4.3
  - Technical Risk Factor 6. Moorings are similar to others WHOI has successfully deployed and maintained. Addition of EOM increased the risk level from 3. The integration of the moorings will be the technically challenging part of this site. AUV docking is new but recently there have been limited successes with AUV docking; project funds were included to extend the state-of-the-art in AUV docking but this is not the only source of funding for advancement of this capability. The Risk Percentage reflects uncertainty in design cost rather than manufacturing.
  - Cost Risk Factor 4. Mooring types proposed are reasonably common at WHOI. The Risk Percentage reflects uncertainty in labor rather than material.
  - Schedule Risk Factor 8. Quantity of moorings requires a staggered build; if early builds get behind they will ripple forward to remaining Pioneer moorings. The Pioneer moorings are some of the last to be commissioned but overall the site moorings will be incrementally installed and commissioned.

Contingency Rationale

- Shore Station 1.3.3, 1.3.4.4
  - Technical Risk Factor NA.
  - Cost Risk Factor 6. In house facilities estimate and estimate for shore-side software design, development and implementation.
  - Schedule Risk Factor 8. Establishment of modem banks for Iridium telemetry could impact critical path. Work-around would be short-term use of existing modems.

CGSN Basis of Estimate

After developing revised budgets we found that we were unable to fully implement all of the these *Ad Hoc* Team recommendations due primarily to two factors:

- Recommended “enhancements” (effectively scope changes) result in significantly higher NRE and implementation costs
- Refined “bottom-up” cost estimates identified higher costs than originally budgeted for a few items

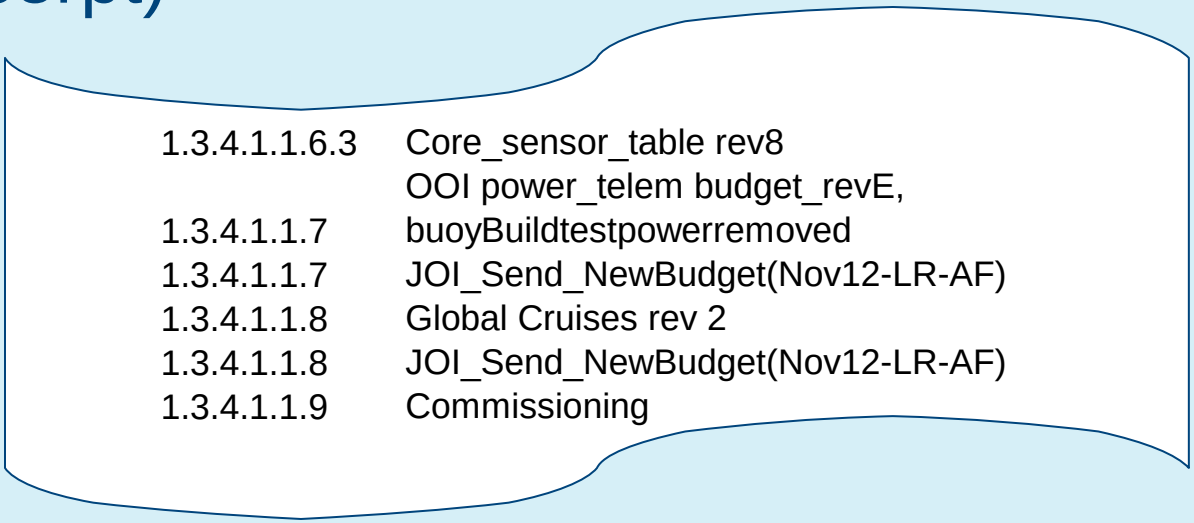
Fixed Budget $ defined scope of Implementation

Estimation Methodology

- Bottom-up Estimate
  - Estimates by people who will do the work
    - Systems, mechanical, electrical engineers
    - Operations
    - Rigging shop
  - Estimates directly from SIO and OSU for their apportioned work
  - Cabling estimate from RSN
- Estimates in WBS
  - Product Oriented
  - Subsection of OOI WBS

Basis of Estimate

- Basis of Estimate Summary Spreadsheet (excerpt)



1.3.4.1.1.6.3	Core_sensor_table rev8
	OOI power_telem budget_revE,
1.3.4.1.1.7	buoyBuildtestpowerremoved
1.3.4.1.1.7	JOI_Send_NewBudget(Nov12-LR-AF)
1.3.4.1.1.8	Global Cruises rev 2
1.3.4.1.1.8	JOI_Send_NewBudget(Nov12-LR-AF)
1.3.4.1.1.9	Commissioning

- Links bottom-up entries to WBS Elements
- Bottom-up entries entered into WHOIGrants for accurate $ generation

Bottoms up Estimate

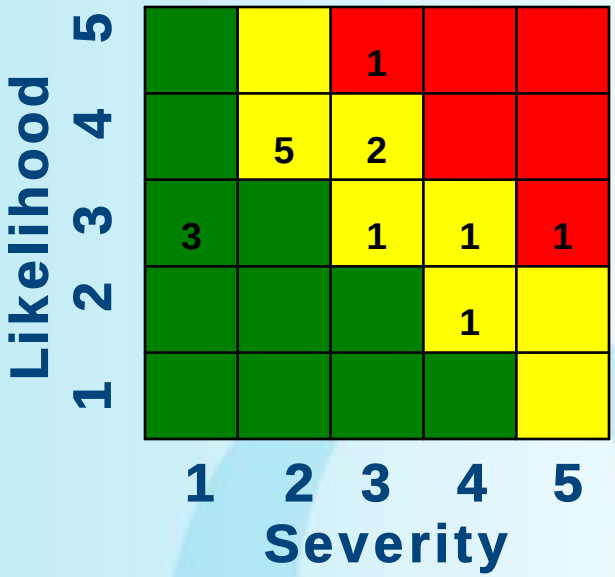
1.3.4.1.1.7 - Test	SE	RE	EII	SEAII	EAIII	Price	Equipment	Materials
Sub-system tests		0.5		0.5				
Complete System Test		0.5	0.5					
System Burn-in		0.25	0.25	0.25				
		1.25	0.75	0.75				2500

- Enumerates subtasks
- Lists Labor categories and quantity required
- Lists Material and Equipment estimates

Risks

- List of Risks — Signell
- “High” Risks & Mitigation — Signell

CGSN Risks and Mitigation



	Concept Design Review	Preliminary Design Review
High	3	2
Medium	9	10
Low	5	3
Closed	0	5

- Upper Ocean Winched Profilers - Design is at Prototype Phase
  - OL held a profiler workshop and identified promising profilers. Development to be accelerated in cooperation with NSF and international partners.
- NOAA Collaboration at Station Papa - NOAA presence may end
  - Monitor NOAA plans. Develop relationships to stay informed of NOAA decisions.

CGSN Risks and Mitigation

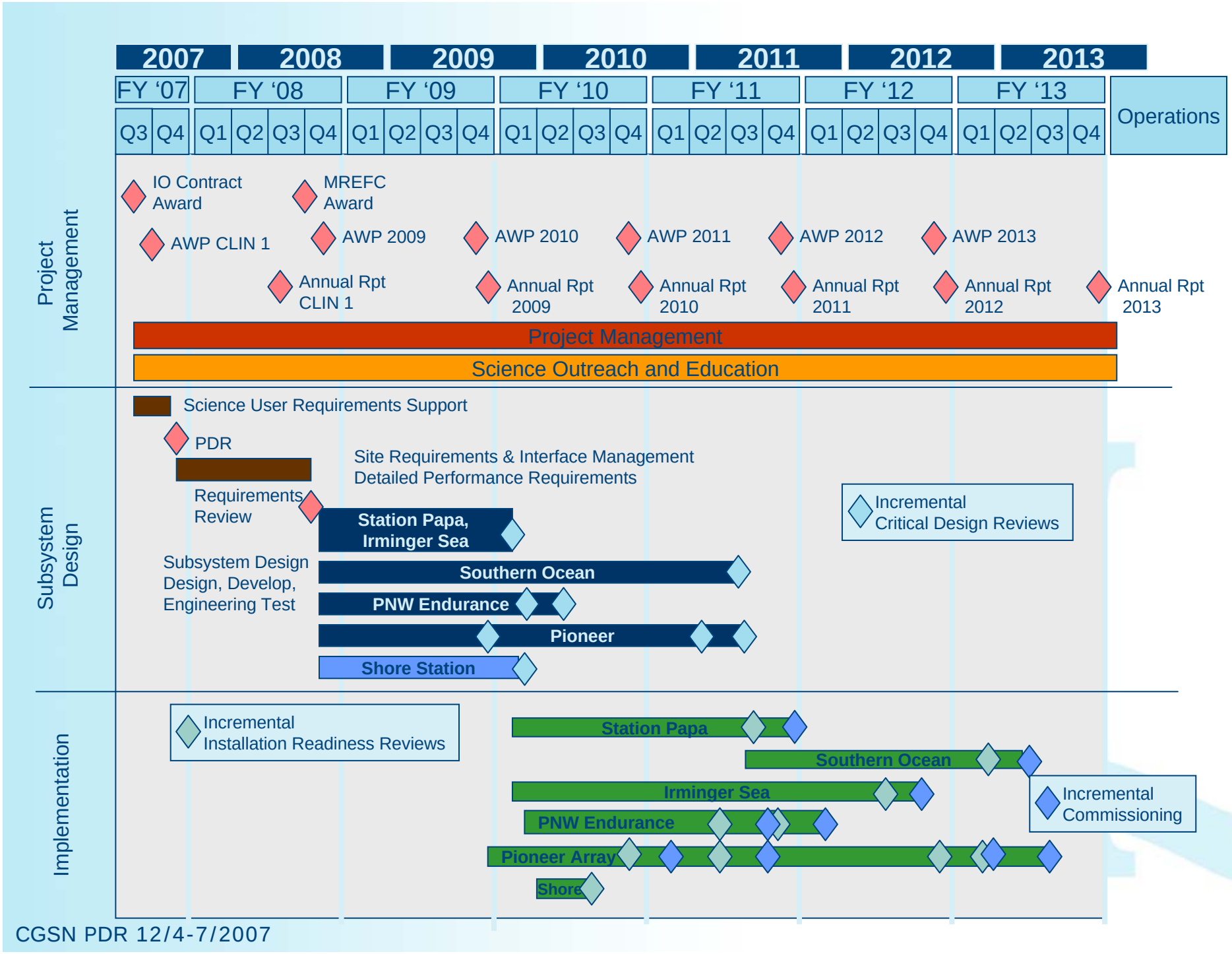
- Sensor degradation
  - Profilers and AUVs will be “parked” below the euphotic zone whenever possible
  - Newly deployed mobile platforms will pass by mooring locations to provide transfer standard
  - Mooring service cruises will be timed so that phenomena of interest (e.g. spring bloom, fall mixing) are observed with fresh sensors
  - Sensors on certain platforms (gliders, AUVs, winched profilers) will be serviceable in-situ
  - All sensors will be post-calibrated upon recovery

CGSN Risks

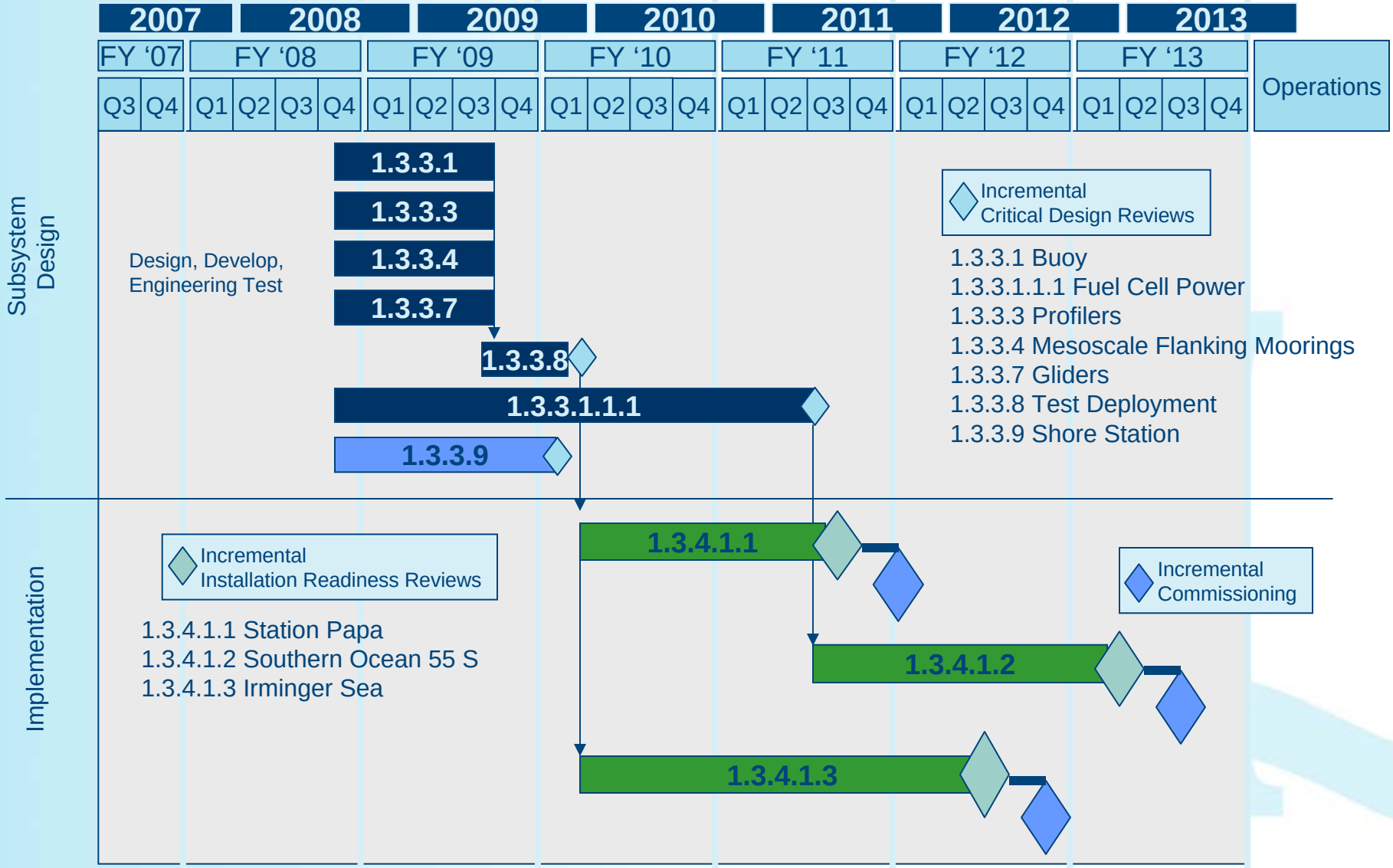
ID	Description of Risk	Rating Likelihood Severity	Mitigation / Action
3001	AUV Recharging	M/4/3	▪ AUVs may be able to be launched from MVCO tower but this would reduce time in study area; ship based support is possible; hybrid of wind, solar, fuel cells will be designed.
3002	Design of Shallow Water Moorings	M/4/2	▪ Shallow Endurance Array site is at 25 meters in Oregon Line. Surface expression will be hardened sphere rather than discus buoy. 7/1/06 – Analyze Potential Stresses for Requirement Specification; Develop mitigation plan with required funding.
3003	Surface-active Layer Bio-fouling	M/4/2	▪ OL will stand up sensor committee to advocate for development of anti-biofouling sensors. ▪ Semi-annual maintenance is built into coastal operations plan; If available, instruments with shutters or wipers will be chosen; Data monitoring and QC to limit distribution of “bad” data; post calibration after maintenance to reinstate data. ▪ Conduct Survey of Commercial Developments.
3006	Duration /Payload of AUVs and Gliders	M/4/2	▪ Review payload requirements for AUVs and gliders; develop higher capability or reduce payload.
3502	Upper Water Column Profilers	H/5/3	▪ OL sponsored profiling workshop in July 2007; winched profilers identified as an enabling technology that NSF should continue to fund outside of OOI; multiple teams will be developing so not a sole design.
3503	EOM Cables in Extreme Environment/Long Duration	M/4/2	▪ EOM cables are limited to one global site (upscope) and four pioneer sites to minimize impact; alternative is EM cable. ▪ Conduct longer term and more extreme environmental testing during design phase.
3504	Acoustic Telemetry Reliability	M/4/2	▪ Primary acoustic links have been eliminated on pioneer, by adding surface piercing moorings; global buoys with acoustic links will internally log data, so risk is reduced to timeliness of data and not loss of data; acoustic testing from gliders to instruments is currently being done by SIO.

CGSN Risks

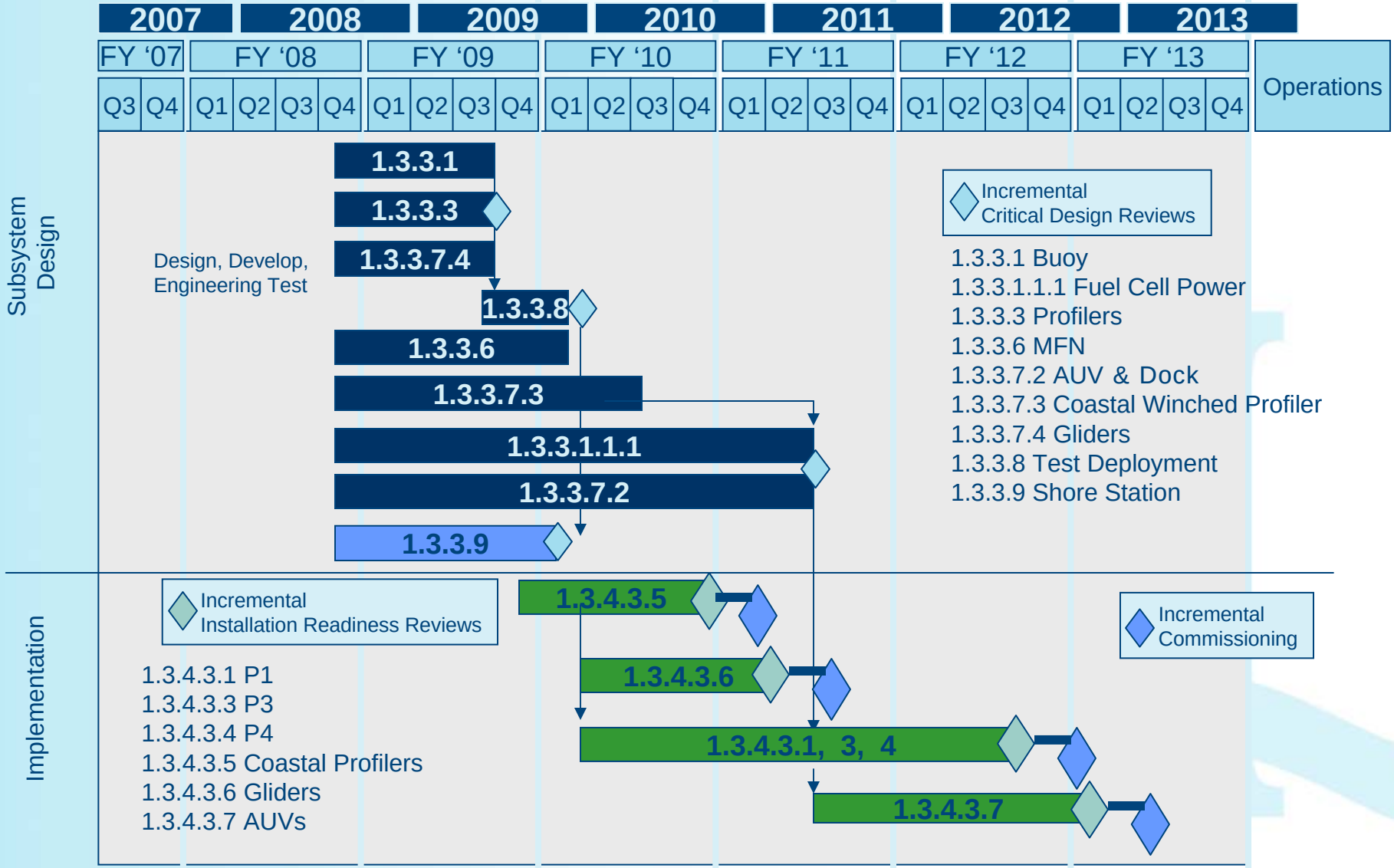
ID	Description of Risk	Rating Likelihood Severity	Mitigation / Action
3505	Sensor Bio-fouling During Year Long Installations	M/4/3	• OL will stand up sensor committee to advocate for development of anti-bio-fouling sensors. • Instruments with shutters or wipers will be chosen; Data monitoring and QC to limit distribution of “bad” data; post calibration after maintenance to reinstate data.
3507	Mooring Failure Recovery	L/3/1	• Predict mooring forces using accurate environmental data and numerical modeling; Provide for measurement of actual mooring forces to use in the event of a failure. • Study past failures for trends during preliminary design phase.
3508	Electronic or Telemetry Failure	L/3/1	• Design system for on-board recording and buffering of data; Provide for remote trigger of a system reset for reprogramming and troubleshooting; timely FMEA. • Study past failures for trends during preliminary design phase.
3511	Buoy Icing	L/3/1	• Design buoy with heavy ice load to be stable; Locate critical items to avoid icing areas; Design to limit ice formation; Use waste heat from power generation. • Study past failures for trends during preliminary design phase.
3512	NOAA Collaboration at Station Papa	H/3/5	• Monitor NOAA plans for Station PAPA and revisit after two years; Develop relationships at NOAA to keep in loop on decisions.
	High Latitude Moorings are New	M/3/4	▪ Design will build on previous experience with moorings in harsh conditions; test deployment planned for Station W off New England coast.
	AUV Docking Development.	M/3/3	▪ Will use cost-sharing funds from the Commonwealth of Massachusetts to accelerate the development of AUV docking.
	Cabling Costs for PNW Endurance	M/2/4	▪ Strong science support for cabling the moorings but costs are high. PDR budget uses costs from RSN IO. Consider contracting cabling directly thru OL


2007
2008
2009
2010
2011
2012
2013
FY '07
FY '08
FY '09
FY '10
FY '11
FY '12
FY '13
Operations
Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4
Project Management
IO Contract Award
MREFC Award
AWP CLIN 1
AWP 2009
AWP 2010
AWP 2011
AWP 2012
AWP 2013
Annual Rpt CLIN 1
Annual Rpt 2009
Annual Rpt 2010
Annual Rpt 2011
Annual Rpt 2012
Annual Rpt 2013
Project Management
Science Outreach and Education
Subsystem Design
Science User Requirements Support
PDR
Site Requirements & Interface Management
Detailed Performance Requirements
Requirements Review
Station Papa, Irminger Sea
Incremental Critical Design Reviews
Subsystem Design
Design, Develop, Engineering Test
Southern Ocean
PNW Endurance
Pioneer
Shore Station
Implementation
Incremental Installation Readiness Reviews
Station Papa
Southern Ocean
Irminger Sea
Incremental Commissioning
PNW Endurance
Pioneer Array
Shore

Global Schedule



Pioneer Schedule



PNW Schedule