Independent Cost Estimate of the U.S. Integrated Ocean Observing System (IOOS®)

Volume II: Detailed Cost Analysis

Prepared for:

The National Aeronautics and Space Administration Science Mission Directorate (NASA SMD)

and

The Interagency Ocean Observation Committee (IOOC)

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Contents

Section 1. Applicable Documents 1
1.1 Source Documents Provided by IOOS Program Office 1
1.1.1 Documents Used for General Reference 1
1.1.2 Documents Used for Cost Inputs 4
1.1.2.1 Data Used for Central Inputs 4
1.1.2.2 Files Used as Input for Federal Costs 5
1.1.2.3 Data Used for Non-Federal Inputs 6
Section 2. Cost Estimating Methodology 7
2.1 Cost Estimating Process 7
2.1.1 Observing Subsystems (WBS 1.1) 8
2.1.1.1 Overview of the Cost Estimation Process 8
2.1.1.2 Basis of Estimate 8
2.1.2 Data Management and Communications (DMAC) (WBS 1.2) 9
2.1.2.1 Overview of the Cost Estimation Process 9
2.1.2.2 Basis of Estimate 10
2.1.3 Modeling and Analysis Subsystem (WBS 1.3) 10
2.1.3.1 Overview of the Cost Estimation Process 10
2.1.3.2 Basis of Estimate 11
2.1.4 Governance and Management System (WBS 1.4) 11
2.1.4.1 Overview of the Cost Estimation Process 11
2.1.4.2 Basis of Estimate 12
2.1.5 Research and Development Subsystem (WBS 1.5) 13
2.1.5.1 Overview of the Cost Estimation Process 13
2.1.5.2 Basis of Estimate 14
2.1.6 Training and Education Subsystem (WBS 1.6) 15
2.1.6.1 Overview of the Cost Estimation Process 15
2.1.6.2 Basis of Estimate 16
2.1.7 Operations and Sustainment (WBS 2.0) 16
2.1.7.1 Basis of Estimate 16
Section 3. Rate Development 17

3.1 Methodology: Labor 17
3.2 Assumptions used in the labor rate development 17
3.3 Approach: Labor 18
3.4 Methodology: Facilities 19
3.5 Assumptions Used in the Facility Cost Development 19
3.6 Approach: Facilities 19
Section 4. Reconciliation with Program Cost Estimate 21
4.1 Overall Comparison 21
4.2 Areas of Largest Deviation 21
4.3 Post Reconciliation Data 22
Section 5. Cost Risk Assessment and S-Curve 23
5.1 S-Curve Methodology 23
Section 6. Cost Detail 25
Section 7. Appendices 40
7.1 IOOS Central DMAC Architecture Description 40
7.1.1 Provenance 40
7.1.2 High-Level Architecture and Components 41
7.1.2.1 System Boundaries 42
7.1.2.2 External Interfaces 42
7.1.3 Component Description and Mapping 43
7.1.3.1 Application 43
7.1.3.2 Database 45
7.1.3.3 Web 45
7.1.3.4 Cloud 45
7.1.4 Storage (TRM) 45
7.1.5 Major Scenarios and Flows 46
7.1.5.1 Data Discovery 46
7.1.5.2 Search 47
7.1.5.3 Modeling and Analysis 48
7.1.5.4 Data Transport 49
7.1.5.5 Archive 50
7.1.6 DMAC Requirements Mapping 51

7.1.6.1 System Design 51
7.1.6.2 Data Collection 51
7.1.6.3 Metadata Management 51
7.1.6.4 Data Archive 51
7.1.6.5 Data Services 51
7.1.6.6 Standards and Interoperability 51
7.1.6.7 Portal Services 51
7.1.6.8 Observing and Sensor/Data Acquisition Services 51
7.1.6.9 Research and Education Services 51
7.1.6.10 Administrative Services 52
7.1.6.11 NOAA 52
7.1.6.12 GEOSS, GOOS and IEOS 52
7.2 WBS Dictionary 81
7.3 Bio/Resume of Team 121
7.3.1 Richard B. Bennett 121
7.3.2 Milana K. Wood 121
7.3.3 Michael J. Fong 122
7.3.4 Cate Heneghan 122
7.3.5 Douglas Hughes 123
7.3.6 Troy J. Schmidt 123
7.4 Acronym List 124
7.5 Asset Gap Analysis 128

Section 1. Applicable Documents

In addition to Volume I, Summary, and this Volume II, Detailed Cost Analysis, we have produced an Excel database (*IOOS_Cost_Matrix_Final_120502.xlsm*) that captures the raw inputs and pricing for this report.

1.1 Source Documents Provided by IOOS Program Office

1.1.1 Documents Used for General Reference

- Cost Analysis Requirements Description (CARD), version 2.0, June 2011: NOA72C10_00 IOOS CARD REPORT V2.0.pdf
- A Blueprint for Full Capability, version 1.0, U.S. IOOS Office, November 2010: us_ioos_blueprint_ver1.pdf
- Integrated Ocean Observing System: High Level Functional Requirements January 2009, version 1.5: NOAA_hlrd_v1_5_01_13_09.pdf
- Cost Studies:
  - IOOS Conceptual Designs status_summary_VADM.pdf
  - IOOSConceptual Design_Cost Est_Viability_Lockheed_to JPL.pdf
  - IOOS Cost Study_Raytheon Final Report - 083106.pdf
- Federal Cost Inputs:
  - Federal Obs Sys_cost for ICE_EPA.xls
  - Federal Obs Sys_cost for ICE_USACE input.xlsx
- IOOS Development Plan: IOOSDevPlan.pdf
- Data Mgmt & Comm Plan: DMAC_Implementation_v1_0.pdf
- Older DMAC Plan: OceanUS Pub 6_DMAC Plan.pdf
- IOOS Blueprint Partner Assessment Results:
  - Intro_US IOOS Assessment Brief_07-29-11 (for ICE).ppt
  - Federal Assessment Packages:
    - BOEMRE Assessment Package.xlsx
    - MMC Assessment Package.xlsx
    - NSF Assessment Package.xlsx
    - USACE Assessment Package.xlsx
    - USCG Assessment Package.xlsx
  - Non-Federal Assessment Packages:
    - AOOS Assessment Package.xlsx
    - GCOOS Assessment Package.xlsx
    - PacIOOS Assessment Package.xlsx
    - SCCOOS Assessment Package.xlsx
    - SECOORA Assessment Package.xlsx
- IOOS Schedules:

  - DMAC_Elements_CostEstimatorSubmission_2011-08-05.xlsx
  - Central Functions_10 Year Sched_2011-0805.xlsx
  - ManagementSchedule.mpp
- IOOS Surface Current Mapping Plan: surfacecurrentplan9_3lowres.pdf
- IOOS Wave Observation Plan: wave_plan_final_03122009.pdf
- Land Mgmt Act 2009: Public Law No 111-11 (HR 146) - Passed & Signed - 033009.doc
- NOAA One Pagers:
  - Obs Systems of Record for IOOS Assessment 11-21-11.xlsx
  - AON (Arctic Observing Network).docx
  - Argo Profiling Floats.docx
  - C-MAN (Coastal-Marine Automated Network).docx
  - CBIBS (Chesapeake Bay Interpretive Buoy System).docx
  - CORS (Continuously Operating Reference Stations).docx
  - CREIOS Atlantic.docx
  - CREIOS Pacific.docx
  - CWB (Coastal Weather Buoys).docx
  - CWOP (Citizen Weather Observer Program).docx
  - DART (Deep-Ocean Assessment and Reporting of Tsunamis).docx
  - Ecosystems Surveys.docx
  - Fish Surveys.docx
  - FOCI (Fisheries Oceanography Coordinated Investigations).docx
  - GOES (Geostationary Operational Environmental Satellite) I-P.docx
  - GOES (Geostationary Operational Environmental Satellite) R-S.docx
  - GOOS Global Drifter Program.docx
  - GOOS GLOSS (Global Sea Level Observing System).docx
  - GOOS Ocean Carbon Networks.docx
  - GOOS ORS (Ocean Reference Stations).docx
  - Habitat Assessment.docx
  - HYDRO (Hydrographic Surveying).docx
  - IOOS High-Frequency Radars.docx
  - IOOS Regional Ocean Observing System.docx
  - Jason Ocean Surface Topography Mission 2-3.docx
  - JPSS (Joint Polar Satellite System).docx
  - Mesonets.docx
  - NCOP (National Current Observation Program).docx
  - NOAA Aircraft.docx
  - NOAA Ships.docx

- NOP (National Observer Program).docx
- NPP (NPOESS Preparatory Project).docx
- NS&T (National Status and Trends).docx
- NWLON (National Water Level Observation Network).docx
- PIRATA.docx
- POES (Polar-Orbiting Operational Environmental Satellite).docx
- PORTS (Physical Oceanographic Real-Time System).docx
- Protected Resources Surveys.docx
- PTWC (Pacific Tsunami Warning Center) Sea Level Network.docx
- RAMA.docx
- ReCON (Real-time Coastal Observation Network).docx
- Shoreline.docx
- SWiM (National Marine Sanctuary System-Wide Monitoring).docx
- SWMP (NERR System-Wide Monitoring).docx
- TAO (Tropical Atmosphere Ocean Array).docx
- VOS (Voluntary Observing Ships).docx

♦ Regional Asset Inventory: IOOS Observing-Assets-Schema_Phase1a_10042011_FINAL.xlsx

♦ Regional Association Conceptual Designs—Updated:

- AOOS Part 1 Narrative 093011.docx
- AOOS Part 1 Issues and Products 093011.xlsx
- AOOS Part 2 Subsystems 100911.xls
- CARICOOS_PRODUCT_PLAN_10_YR.xls
- CARICOOS_SUBSYSTEMS_ed_oct_13_2011.xls
- CeNCOOS_BuildOut_Part1_final.xls
- CeNCOOS_BuildOut_Part2_final.xls
- GCOOS PART ONE DRAFT1.xls
- GCOOS PART TWO DRAFT3.xlsx
- GLOSEA_buildout_PART ONE.xls
- GLOS buildout PART TWO final.xls
- MARACOOS_Part1_Products_FINAL.xlsx
- MARACOOS PART TTWO Subsystems FINAL Update 10-7-2011.xls
- NANOOS Part1.docx
- NANOOS Obs_4.xls
- Northeast Regional Build Out Plan_Exec_Summ_sept30_2011.docx
- Northeast Regional Build Out Plan_Full draft Part1 sept30_2011.docx
- Northeast Regional Build Out Plan_Full draft Part2_oct_14_2011.docx

  - PacIOOS_Part_1.xlsx
  - PacIOOS PART TWO Subsystem-2.xls
  - SCCOOS_Part1.doc
  - SCCOOS_Part2_final.xls
  - SECOORA_BuildOut_Submittal_14Oct2011_VERSION4.pdf
- Regional Association Conceptual Designs—Older:
  - AOOS Comprehensive Conceptual Designs DEC 07.pdf
  - AOOS FY08-10 Conceptual Design Dec 07.pdf
  - CaRA_CarICOOS_conceptual_design.pdf
  - CeNCOOS Conceptual Design.pdf
  - GCOOS_Concept_Design_Version1.pdf
  - GLOS-RCOOS-CPv1.pdf
  - MARCOOS Conceptual Design Document V1 0 12-19-07.pdf
  - NANOOS_Conceptual_Design-1.pdf
  - NERACOOS conceptual design.pdf
  - PacIOOS.CD.pdf
  - SCCOOS_RCOOSConceptualDesign_1.0_FNL.pdf
  - SECOORA.pdf
- Data Volume: IOOS RA Data Volume Input_2012-0201.doc
- Syntheses of RA Inputs:
  - Part1synthesis_WS.xls
  - Part2synthesis_WS.xls
  - Part2synthesis_Dec9_2011.xls
- Obs Systems of Record for IOOS Assessment 11-21-11.xlsx
- Common platforms&models_WS.doc
- Common product services.doc

1.1.2 Documents Used for Cost Inputs

1.1.2.1 Data Used for Central Inputs

- Cost Analysis Requirements Description, version 2.0, June 2011
- A Blueprint for Full Capability, Version 1.0, U.S. IOOS Office, November 2010
- Integrated Ocean Observing System: High Level Functional Requirements January 2009, version 1.5
- http://www.opm.gov/oca/12tables/indexGS.asp
- http://www.bls.gov/news.release/pdf/eci.pdf
- Central Functions_10 Year Sched_2011-0805.xlsx

1.1.2.2 Files Used as Input for Federal Costs

- Federal Cost Inputs:
  - Federal Obs Sys_cost for ICE_EPA.xls
  - Federal Obs Sys_cost for ICE_USACE input.xlsx
- IOOS Blueprint Partner Assessment Results:
  - Intro_US IOOS Assessment Brief_07-29-11 (for ICE).ppt
  - Federal Assessment Packages
    - BOEMRE Assessment Package.xlsx
    - MMC Assessment Package.xlsx
    - NSF Assessment Package.xlsx
    - USACE Assessment Package.xlsx
    - USCG Assessment Package.xlsx
- NOAA One Pagers:
  - Obs Systems of Record for IOOS Assessment 11-21-11.xlsx
  - AON (Arctic Observing Network).docx
  - Argo Profiling Floats.docx
  - C-MAN (Coastal-Marine Automated Network).docx
  - CBIBS (Chesapeake Bay Interpretive Buoy System).docx
  - CORS (Continuously Operating Reference Stations).docx
  - CREIOS Atlantic.docx
  - CREIOS Pacific.docx
  - CWB (Coastal Weather Buoys).docx
  - CWOP (Citizen Weather Observer Program).docx
  - DART (Deep-Ocean Assessment and Reporting of Tsunamis).docx
  - Ecosystems Surveys.docx
  - Fish Surveys.docx
  - FOCI (Fisheries Oceanography Coordinated Investigations).docx
  - GOES (Geostationary Operational Environmental Satellite) I-P.docx
  - GOES (Geostationary Operational Environmental Satellite) R-S.docx
  - GOOS Global Drifter Program.docx
  - GOOS GLOSS (Global Sea Level Observing System).docx
  - GOOS Ocean Carbon Networks.docx
  - GOOS ORS (Ocean Reference Stations).docx
  - Habitat Assessment.docx
  - HYDRO (Hydrographic Surveying).docx
  - IOOS High-Frequency Radars.docx
  - IOOS Regional Ocean Observing System.docx
  - Jason Ocean Surface Topography Mission 2-3.docx

- JPSS (Joint Polar Satellite System).docx
- Mesonets.docx
- NCOP (National Current Observation Program).docx
- NOAA Aircraft.docx
- NOAA Ships.docx
- NOP (National Observer Program).docx
- NPP (NPOESS Preparatory Project).docx
- NS&T (National Status and Trends).docx
- NWLON (National Water Level Observation Network).docx
- PIRATA.docx
- POES (Polar-Orbiting Operational Environmental Satellite).docx
- PORTS (Physical Oceanographic Real-Time System).docx
- Protected Resources Surveys.docx
- PTWC (Pacific Tsunami Warning Center) Sea Level Network.docx
- RAMA.docx
- ReCON (Real-time Coastal Observation Network).docx
- Shoreline.docx
- SWiM (National Marine Sanctuary System-Wide Monitoring).docx
- SWMP (NERR System-Wide Monitoring).docx
- TAO (Tropical Atmosphere Ocean Array).docx
- VOS (Voluntary Observing Ships).docx

1.1.2.3 Data Used for Non-Federal Inputs

- Part2synthesis_Dec9_2011.xls
- AOOS Part 2 Subsystems 100911.xls
- CARICOOS_SUBSYSTEMS_ed_oct_13_2011.xls
- CeNCOOS_BuildOut_Part2_final.xls
- GCOOS PART TWO DRAFT3.xlsx
- GLOS buildout PART TWO final.xls
- MARACOOS PART TTWO Subsystems FINAL Update 10-7-2011.xls
- NANOOS Obs_4.xls
- Northeast Regional Build Out Plan_Full draft Part2_oct_14_2011.docx
- PacIOOS PART TWO Subsystem-2.xls
- SCCOOS_Part2_final.xls
- SECOORA_BuildOut_Submittal_14Oct2011_VERSION4.pdf

Section 2. Cost Estimating Methodology

2.1 Cost Estimating Process

The IOOS independent cost estimates were developed by the ICE team in Phases 3 and 4 of the cost plan. The Phase 3 activity developed cost estimates with uncertainty assessments for the Central Function elements and integrated them with Federal and Non-Federal contribution elements. The Phase 4 activity performed a comparison and reconciliation of the independent estimates of the JPL and PCE teams.

The cost estimate was organized according to the IOOS Work Breakdown Structure (WBS) presented in the CARD, reflected in Section 7.2. Microsoft Excel was used to collect the resource inputs and then apply appropriate rates and factors to estimate each line item and roll up the costs. The rates developed and used for the IOOS ICE are described in Section 3, Rate Development.

The IOOS ICE team initiated the cost process by reviewing all available documentation provided by the IOOS Program Office, defining the science requirements, technical design, and overall goals of the IOOS system. Several iterations of the cost estimate were generated to assure a credible estimate for each WBS Level 3 element. The cost estimating process is presented in Figure 2.1-1.

To ensure completeness and accuracy, reviews were held at progressive milestones as the estimate evolved. Functional and senior management assessed the IOOS ICE cost estimate based on the science, technical, and programmatic requirements set forth in the CARD; including its feasibility and resulting cost realism.

The sections below summarize the overall cost estimating methodology, assumptions, and influential drivers by the major IOOS WBS Elements.

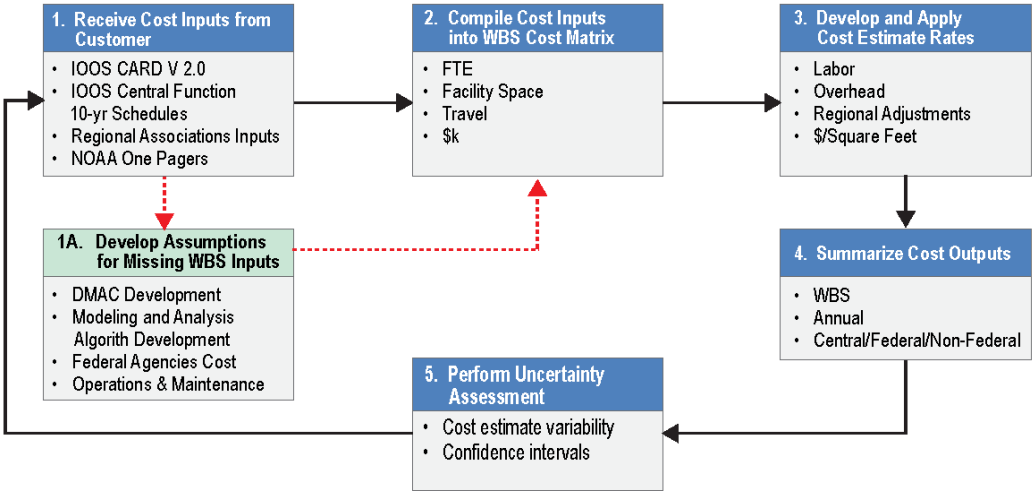


Figure 2.1-1. *The 3CV ICE estimate was developed using a process tailored to the design maturity of the IOOS and information available to the ICE team.*

2.1.1 Observing Subsystems (WBS 1.1)

2.1.1.1 Overview of the Cost Estimation Process

The cost estimation process used for the Observing Subsystem followed the cost estimating procedure described in Section 2.1. The steps included the following activities:

- Review of the IOOS source documents in Section 1.1 to understand the IOOS architecture and system concept with particular emphasis on the Observing subsystems.
- Utilization of the WBS and dictionary defined in the CARD (Appendix C and Section 1.2.5) to capture and organize the Observing subsystems cost.
- Collection of resource inputs from available documents as supplied by IOOS. This includes workforce, assets, and facilities information. Inputs are entered into an Excel file and organized by WBS and partners.
- Spreading of resources by fiscal year for a 10-year buildout period to reach full capability, and then followed by 5-years of sustainment.
- Definition of rates and factors were determined and then applied to the resource inputs. This includes fully burdened labor rates for workforce and square footage rates for facilities.
- Selection of an inflation rate for escalating the cost from a Base Year (BY) to Real Year (RY) dollars.
- JPL Independent Review of the cost estimate and assumptions to ensure the ICE is reasonable and complete.

The Observing subsystems cost estimate is primarily a pricing of each partner's identified assets for conducting oceanographic observations and measurements.

2.1.1.2 Basis of Estimate

The basis of estimate for the observing system is identified in the cost estimation in column I of the *WBS Matrix_Input* spreadsheet of the *IOOS_Cost_Matrix_Final_120502.xlsm* workbook.

2.1.1.2.1 Central Function

The Central function workforce for the first 10 years of development was provided by IOOS in the form of an Excel file labeled "Central Functions_10 Year Sched_2011-0805.xlsx".

Workforce staffing for years 11-15 were assumed to be a continuation of the workforce in year 10 of the development period.

The Central function facilities definition was supplied by the CARD Report file "NOA72C10_00 IOOS CARD REPORT V2.0.pdf". Facilities were broken down into units of square feet and then priced by type and location including annual inflation factors.

2.1.1.2.2 Federal Contribution

With the exception of NOAA and USACE, little information was provided from the participating Federal partners. Therefore, expert assessment was used to categorize federal agency oceanographic contributions into major, average and minor groups. Total funding for agencies within each group was then identified along with the portion allocated to oceanography. Each agency's allocated funding was then subdivided into the WBS structure by percentage. Table 6-5, Parametrically Derived Federal Cost Estimates by Year, provides the expert determined costs for the Federal assets by partner.

2.1.1.2.3 Non-Federal Contribution

The Non-Federal assets were supplied by the regions in the form of 11 plans. Asset resource information came from data that each organization provided in the files shown in Section 1.

Costs that were collected include workforce, assets, along with operations and maintenance (O&M).

The O&M inputs were used for years 11-15 sustainment cost.

2.1.2 Data Management and Communications (DMAC) (WBS 1.2)

2.1.2.1 Overview of the Cost Estimation Process

The cost estimation process used for the DMAC subsystem followed the cost estimating procedure described in Section 2.1. The steps included the following activities:

- Review of the IOOS source documents in Section 1.1 to understand the IOOS DMAC architecture.
- Utilization of the WBS and dictionary defined in the CARD (Appendix C and Section 1.2.5) to capture and organize the DMAC subsystems costs.
- Collection of resource inputs from available documents as supplied by IOOS. This includes workforce, computing hardware, and facilities information. Inputs are entered into an Excel file and organized by WBS and partners.
- Spreading of resources by fiscal year for a 10-year buildout period to reach full capability, and then followed by 5-years of sustainment.
- Definition of rates and factors were determined and then applied to the resource inputs. This includes fully burdened labor rates for workforce and square footage rates for facilities.
- Selection of an inflation rate for escalating the cost from a Base Year (BY) to Real Year (RY) dollars.
- JPL Independent Review of the cost estimate and assumptions to ensure the ICE is reasonable and complete.

The Central Function's DMAC cost estimate is primarily driven by labor. The Non-Federal contribution is driven by the pricing of each partner's identified workforce requirements

2.1.2.2 Basis of Estimate

As the source documentation was assessed, the following assumptions were made about the DMAC architecture, its development and operational profile.

- Prior to revising the architecture in anticipation of detailed design, the system requirements will be scrubbed, as they are not wholly consistent with the accepted definition. "Requirements should be documented, actionable, measurable, testable, traceable, related to identified business needs or opportunities, and defined to a level of detail sufficient for system design."
- The workforce estimation at all levels of the DMAC WBS was heavily weighted with senior people to comply with the following assumption from page 1-6 of the High Level Functional Requirements document:
  - Development and maintenance teams will have average to high levels of experience, skills, and abilities.
  - This reduces risk and to assures full completion of the system within the proscribed schedule.
- The integration effort estimated for each repository was done on a worst-case basis with no re-use. This was done to assure completion within the proscribed schedule and in deference to the requirement not to force change in the repositories' interfaces or internal processing.

2.1.3 Modeling and Analysis Subsystem (WBS 1.3)

2.1.3.1 Overview of the Cost Estimation Process

The cost estimation process used for the Modeling and Analysis subsystem followed the general cost estimating procedure described in Section 2.1. The steps include the following activities:

- Review of the IOOS Blueprint and IOOS CARD to understand the IOOS architecture and system concept with particular emphasis on the role of the Modeling and Analysis element.
- Utilization of the WBS and dictionary defined in the CARD (Appendix C and Section 1.2.5) to capture and organize the Modeling and Analysis costs.
- Collection of resource inputs from available documents. This includes workforce, assets, facilities, travel, and other cost. Inputs are entered into an Excel file and organized by WBS and partners.
- Spreading of resources by fiscal year according to a 10 year development period to reach full capability, and then followed by 5 year of operations. Continued operations beyond year 15 are outside the scope of this ICE.
- Definition of rates and factors that are applied to the resource inputs. This

includes fully burdened labor rate for workforce and square footage rate for facilities.

- Selection of an inflation rate for escalating the costs from a Base Year (BY) to Real Year (RY).
- Review of the cost estimate and assumptions with senior management to ensure the ICE is reasonable and complete.

2.1.3.2 Basis of Estimate

2.1.3.2.1 Central Function

For Modeling and analysis, the cost estimate is primarily a pricing of each partner's proposal for conducting Modeling and Analysis activities. The Central Function estimate was augmented with an ICE estimate of 6 FTEs for Customer needs management which includes a CRM Manager, CRM COTS Integrator, and a CRM Engineer as well as 7 FTEs for IOOS sponsored and other model management, which includes M&A Lead Engineer, M&A Design Engineer, and M&A I/F Engineer.

2.1.3.2.2 Federal Contribution

Very little information was collected from the participating Federal assets. Any source material that was provided did not identify any meaningful inputs for the area of M&A. Therefore, an assumption was made for the Federal partners and the development cost inputs were placed under a unique WBS element that was added (1.3.5, All Federal Inputs). The assumed cost for the Federal partners is as provided in Table 6-5, Parametrically Derived Federal Cost Estimates by Year.

2.1.3.2.3 Non-Federal Contribution

The Non-Federal assets were supplied by the regions in the form of 11 plans. Asset resource information came from data that each organization provided in the files shown in Section 1.

Costs that were collected include workforce, assets, along with operations and maintenance (O&M).

The O&M inputs were used for years 11-15 sustainment cost.

2.1.4 Governance and Management System (WBS 1.4)

2.1.4.1 Overview of the Cost Estimation Process

The cost estimation process used for the Governance and Management System (G&M) followed the general cost estimating procedure described in Section 2.1. The steps include the following activities:

- Review of the IOOS Blueprint and IOOS CARD to understand the IOOS architecture and system concept with particular emphasis on the role of the R&D element.
- Utilization of the WBS and dictionary defined in the CARD (Appendix C

and Section 1.2.5) to capture and organize the Governance and Management System costs.

- Collection of resource inputs from available documents. This includes workforce, assets, facilities, travel, and other cost. Inputs are entered into an Excel file and organized by WBS and partners.
- Spreading of resources by fiscal year according to a 10-year buildout period to reach full capability, and then followed by 5 year of sustainment. Work beyond year 15 is outside the scope of this ICE.
- Definition of rates and factors that are applied to the resource inputs. This includes fully burdened labor rate for workforce and square footage rate for facilities.
- Selection of an inflation rate for escalating the costs from a Base Year (BY) to Real Year (RY).
- Review of the cost estimate and assumptions with senior management to ensure the ICE is reasonable and complete.

The Governance and Management System is a very straight forward element of the IOOS system that was relatively easy to characterize and apply the standard cost estimating process. The G&M cost estimate is primarily a pricing of the G&M estimates from the central function, federal contributors and non-federal contributors.

2.1.4.2 Basis of Estimate

The basis of estimate for the Governance and Management Subsystem is identified in the cost estimation in column I of the *WBS Matrix_Input* spreadsheet of the *IOOS_Cost_Matrix_Final_120502.xlsm* workbook.

2.1.4.2.1 Central Function

The Central function workforce staffing needs for the first 10 years of development was provided in the IOOS CARD in Section 4.1. This staffing requirement was only provided at level 3 of the WBS. For the Governance and Management element, an allocation of the staffing was made to the next level down based on engineering judgment.

The Central function workforce for the sustainment period (years 11-15) of G&M was assumed to be a continuation of the workforce staffing in year 10 of the buildout period.

2.1.4.2.2 Federal Contribution

Very little information was collected from the participating Federal contributors. Any source material that was provided did not identify any meaningful inputs for the area of G&M. Therefore, an assumption was made for the Federal contributors, and the buildout cost inputs were placed under a new, unique WBS element (1.4.8, All Federal Assets). The assumed costs for the Federal contributors are provided in Table 6-5, Parametrically Derived Federal Cost Estimates by Year.

2.1.4.2.3 Non-Federal Contribution

There are 11 Non-Federal contributors. Information for the first 10 years of buildout came from data that each contributor provided in the files shown in Section 1. Buildout costs include workforce and budgets requests for meetings, workshops, and travel.

The Non-Federal Governance and Management estimates for years 11-15 were assumed to be a continuation of the staffing requirements and activities in year 10 of the buildout period.

2.1.5 Research and Development Subsystem (WBS 1.5)

2.1.5.1 Overview of the Cost Estimation Process

The cost estimation process used for the research and development (R&D) subsystem followed the general cost estimating procedure described in Section 2.1. The steps include the following activities:

- Review of the IOOS Blueprint and IOOS CARD to understand the IOOS architecture and system concept with particular emphasis on the role of the R&D element.
- Utilization of the WBS and dictionary defined in the CARD (Appendix C and Section 1.2.5) to capture and organize the R&D costs.
- Collection of resource inputs from available documents. This includes workforce, assets, facilities, travel, and other costs. Inputs are entered into an Excel file and organized by WBS and partners.
- Spreading of resources by fiscal year according to a 10 year development period to reach full capability, and then followed by 5 year of operations. Continued operations beyond year 15 are outside the scope of this ICE.
- Definition of rates and factors that are applied to the resource inputs. This includes fully burdened labor rate for workforce and square footage rate for facilities.
- Selection of an inflation rate for escalating the costs from a Base Year (BY) to Real Year (RY).
- Review of the cost estimate and assumptions with senior management to ensure the ICE is reasonable and complete.

For R&D, this is a very straight forward element of the IOOS system that was relatively easy to characterize and apply the standard cost estimating process. The R&D cost estimate is primarily a pricing of each contributor's proposal for conducting R&D activities.

2.1.5.2 Basis of Estimate

As the data were being collected and assessed, the following assumptions were made on how the information was processed and used for this ICE.

- Non-Federal R&D data are considered proposals for activities that will provide a future enhancement to the IOOS.
- An assessment was not made as to which activities should or should not be funded.
- Assume that all proposals are funded to determine an upper bound for the Total Ownership Cost of this WBS element.
- Assume that the IOOS will use this ICE to define a budget for this element and allocate funding to each participating organization.
- Rates used to price the resource inputs (e.g., labor) are based on the national average by region.

2.1.5.2.1 Central Function

The Central function workforce staffing needs for the first 10 years of development was provided in the IOOS CARD in Section 4.1. This staffing requirement was only provided at level 3 of the WBS. A breakout of the staffing to the next level down was provided by the customer in a separate file (Central Functions_10 Year Sched_2011-0805.xlsx).

The Central function workforce staffing for years 11-15 which cover the sustainment period of R&D were assumed to be a continuation of the workforce staffing in year 10 of the development period. The operational aspects of WBS 1.0 are captured under WBS 2.2, System operations, with the Central function R&D sustainment costs defined under WBS 2.2.5.1.

2.1.5.2.2 Federal Contribution

Very little information was collected from the participating Federal contributors. Any source material that was provided did not identify any meaningful inputs for the area of R&D. Therefore, an assumption was made for the Federal partners and the development cost inputs that placed them under an added unique WBS element (1.5.8, All Federal Assets). The assumed costs for the Federal partners are provided in Table 6-5, Parametrically Derived Federal Cost Estimates by Year.

For the sustainment period in years 11-15, the Federal R&D inputs were assumed to be a continuation of the staffing requirements and activities in year 10 of the development period. The operational aspects of WBS 1.0 are captured under WBS 2.2, System operations, with the R&D sustainment costs defined under WBS 2.2.5.2.

2.1.5.2.3 Non-Federal Contribution

The Non-Federal contributors are comprised of 11 organizations. For the first 10 years of development, all R&D resource information came from data that each organization provided in the files shown in Section 1.

Development costs that were collected include workforce and budget requests for meetings, workshops, and research activities.

The Non-Federal R&D inputs for years 11-15 which cover the sustainment period of R&D were assumed to be a continuation of the staffing requirements and activities in year 10 of the development period. The operational aspects of WBS 1.0 are captured under WBS 2.2, System operations, with the Non-Federal R&D sustainment costs defined under WBS 2.2.5.3.

2.1.6 Training and Education Subsystem (WBS 1.6)

2.1.6.1 Overview of the Cost Estimation Process

The cost estimation process used for the Training and Education Subsystem (T&E) followed the general cost estimating procedure described in Section 2.1. The steps include the following activities:

- Review of the IOOS Blueprint and IOOS CARD to understand the IOOS architecture and system concept with particular emphasis on the role of the R&D element.
- Utilization of the WBS and dictionary defined in the CARD (Appendix C and Section 1.2.5) to capture and organize the T&E costs.
- Collection of resource inputs from available documents. This includes workforce, assets, facilities, travel, and other cost. Inputs are entered into an Excel file and organized by WBS and partners.
- Spreading of resources by fiscal year according to a 10-year buildout period to reach full capability, and then followed by 5 year of sustainment. Work beyond year 15 is outside the scope of this ICE.
- Definition of rates and factors that are applied to the resource inputs. This includes fully burdened labor rate for workforce and square footage rate for facilities.
- Selection of an inflation rate for escalating the costs from a Base Year (BY) to Real Year (RY).
- Review of the cost estimate and assumptions with senior management to ensure the ICE is reasonable and complete.

The Training and Education Subsystem, is a very straight forward element of the IOOS system that was relatively easy to characterize and apply the standard cost estimating process. The T&E cost estimate is primarily a pricing of the T&E estimates from the central function, federal contributors and non-federal contributors.

2.1.6.2 Basis of Estimate

2.1.6.2.1 Central Function

The Central Function workforce staffing needs for the first 10 years of development was provided in the IOOS CARD in Section 4.1. This staffing requirement was only provided at level 3 of the WBS. For the T&E element, an allocation of the staffing was made to the next level down based on engineering judgment.

The Central function workforce for the sustainment period (years 11-15) of T&E was assumed to be a continuation of the workforce staffing in year 10 of the buildout period.

2.1.6.2.2 Federal Contribution

Very little information was collected from the participating Federal contributors. Any source material that was provided did not identify any meaningful inputs for the area of T&E. Therefore, an assumption was made for the Federal contributors, and the buildout cost inputs were placed under a new, unique WBS element that was added (1.4.8, All Federal Assets). The assumed costs for the Federal contributors are provided in Table 6-5, Parametrically Derived Federal Cost Estimates by Year.

For the sustainment period in years 11-15, the Federal T&E inputs were assumed to be a continuation of the staffing requirements and activities in year 10 of the development period. The operational aspects of WBS 1.0 are captured under WBS 2.2, System operations, with the T&E sustainment costs defined under WBS 2.2.5.2.

2.1.6.2.3 Non-Federal Contribution

There are 11 Non-Federal contributors. Information for the first 10 years of buildout came from data that each contributor provided in the files shown in Section 1. Buildout costs include workforce and budgets requests for meetings, workshops, and travel.

The Non-Federal T&E estimates for years 11-15 were assumed to be a continuation of the staffing requirements and activities in year 10 of the buildout period.

2.1.7 Operations and Sustainment (WBS 2.0)

2.1.7.1 Basis of Estimate

The technical and management efforts of directing and controlling an integrated engineering effort, sustaining the 1.x functions during O&M, replenishment of Hardware and Software, improvements and new developments as best understood by the ICE team are all covered in this WBS element. As with the buildout, the same customer provided data sources were used to estimate the O&M activities under this WBS element.

Section 3. Rate Development

3.1 Methodology: Labor

The data sources used for the labor rate development are as follows:

- JPL's National survey of salaries.
- OPM 2012 Salary Guide (http://www.opm.gov/oca/12tables/indexGS.asp).
- OMB Table 10.1—GROSS DOMESTIC PRODUCT AND DEFLATORS USED IN THE HISTORICAL TABLES: 1940–2016.
- Bureau of Labor Statistics, US Department of Labor, Employment Cost Index Dec 2011 http://www.bls.gov/news.release/pdf/eci.pdf.

3.2 Assumptions used in the labor rate development

Assumptions used in the labor rate devolvement are as follows:

- JPL's National survey of salaries was used as the basis of the salaries used. The Top 2 or 3 grades from each category used in the cost estimate were averaged to form a composite rate for that category.
- Each regional association has a separate regional modification applied to it for their specific location, based on the OPM 2012 Salary Guide regional adjustments of GS rates.
  - The following labor categories were used:
    - Management.
    - Engineering-Software.
    - Engineering-Hardware.
    - Scientist.
    - Administrative/Secretarial.
    - Business Administration.
    - GS-15-Step 8 (2012 DC).
- To fully burden (to account for fringes) the annual salary, we used the BLS Employment Cost index memo as a guide –Fringe Benefit Cost Factor (42%).
- To account for Corporate overhead and Computers/Phones/and Occupancy cost for employee's, JPL rates were used as a guide (45% corporate overhead, $17,028/Person Work Year)

3.3 APPROACH: LABOR

- Estimating Labor:
  - Every line of labor is assigned 2 qualifiers:
    - Labor Category:
      - → Management.
      - → Engineering-Software.
      - → Engineering-Hardware.
      - → Scientist.
      - → Administrative/Secretarial.
      - → Business Administration.
      - → GS-15-Step 8 (2012 DC).
    - Regional Adjustment:
      - → Gulf of Alaska/Arctic.
      - → Caribbean/ Puerto Rico/US Virgin Islands.
      - → Central and Northern California.
      - → Gulf of Mexico/Gulf Florida-Texas.
      - → Great Lakes.
      - → Cape Cod/MA/NC.
      - → Washington/Oregon/Northern California.
      - → Main to MA/ Nova Scotia.
      - → Hawaii.
      - → Southern California.
      - → North Carolina to Atlantic Coast of Florida.
      - → Washington D.C.
    - Labor is then entered as Full Time Equivalents (FTE's).
    - The resulting fully burdened labor rates are provided in Table 3.6-1.
    - The resulting Regional Adjustment factors are provided in Table 3.6-2.
    - All costs were inflated using the OMB inflation index provided in Table 3.6-3.

3.4 METHODOLOGY: FACILITIES

The data sources used for the facilities rate development are as follows:

- IOOS CARD.
- PRICE Systems True Planning Cost Model: Datacenter facilities cost for average economic area. Includes rent costs, utility costs and maintenance fees.
- Review of JPL's Facilities Costs.
- MarketView Reports: www.cbre.com/research.

3.5 ASSUMPTIONS USED IN THE FACILITY COST DEVELOPMENT

Assumptions used in the facility cost devolvement are as follows:

- Square Foot (sq/ft) cost represents cost of facilities, maintenance, utilities, and, physical and network security.
- Annual inflation to account for increases in expenses over the program life.

3.6 APPROACH: FACILITIES

- Central Function:
  - Where explicitly identified the sq/ft requirement was multiplied by the annual $60 sq/ft rate to generate the fully burden office sq/ft ($) requirement.
  - The occupancy cost of existing facilities is covered in the overhead rate which is applied to all FTEs.
- Non-Federal Contribution:
  - Where explicitly identified, the sq/ft requirement was multiplied by the annual $60 sq/ft rate to generate the fully burden office sq/ft ($) requirement.
  - The occupancy cost of existing facilities is covered in the overhead rate which is applied to all FTEs.
- Federal Contribution:
  - The cost for federal Contribution facilities cost is assumed to be included in their contribution allocation.

Table 3.6-1. ICE salary rates used by category.

	Management	Engineering-Software	Engineering-Hardware	Scientist	Administrative/ Secretarial	Business Admin	GS-15-Step 8 (2012 DC)
Base Salary	$188,905	$144,394	$147,280	$147,449	$66,369	$116,991	$152,635
Benefits/Fringe (42%)	$79,340	$60,645	$61,857	$61,929	$27,875	$49,136	$64,107
Computers/Phones/ Occupancy/Travel	$17,028	$17,028	$17,028	$17,028	$17,028	$17,028	$17,028
Overhead (45%)	$120,710	$92,267	$94,112	$94,220	$42,410	$74,757	$97,534
TOTAL Rate annual	$406,074	$314,404	$320,348	$320,697	$153,714	$257,968	$331,378

Table 3.6-2. Regional adjustment factors used.

Region	Regional Adjustment Factor
Gulf of Alaska/Arctic	103%
Caribbean/ Puerto Rico/US Virgin Islands	94%
Central and Northern California	101%
Gulf of Mexico/Gulf Florida-Texas	100%
Great Lakes	103%
Cape Cod/MA/NC	97%
Washington/Oregon/Northern California	100%
Main to MA/ Nova Scotia	103%
Hawaii	96%
Southern California	105%
North Carolina to Atlantic Coast of Florida	106%
Washington D.C.	103%

Table 3.6-3. OMB inflation rates used (base 2012).

Year	OMB Inflation by Year	OMB Compound Inflation Rate (base 2012)
2012	100.00%	100.00%
2013	101.72%	101.72%
2014	101.86%	103.62%
2015	101.92%	105.60%
2016	101.91%	107.62%
2017	101.91%	109.67%
2018	101.91%	111.76%
2019	101.91%	113.89%
2020	101.91%	116.07%
2021	101.91%	118.28%
2022	101.91%	120.54%
2023	101.91%	122.83%
2024	101.91%	125.18%
2025	101.91%	127.56%
2026	101.91%	130.00%

Section 4. Reconciliation with Program Cost Estimate

4.1 Overall Comparison

The requirement for reconciliation with the Program Cost Estimate (PCE) was part of the Statement of Work for the ICE development. The requirements of the reconciliation were:

1. The federal agencies involved in ocean observing will provide a Program Cost Estimate of the System to the Independent Cost Estimate team.
2. Provide an assessment of the alignment of the two cost estimates.

The PCE team and the ICE team delivered their initial estimates to the customer on March 15, 2012. At that time, the two initial estimates for total Life Cycle cost over the 15 year project duration were within 30% of each other, the PCE estimate at $40.6B and the ICE estimate at $54.6B.

4.2 Areas of Largest Deviation

During the reconciliation process, a number of key items were addressed. Each team presented their respective methodology and cost development process. Differences in assumptions were summarized along with their cost impacts. Where appropriate, updates to the estimates were incorporated based on a clarification or adjustment of assumptions by the customer. The main areas where differences arose included labor and facilities costs, regional asset costs, federal agency contributions, and cost growth profiles over time. The following list contrasts the differences between the ICE and PCE teams for each topic.

- Labor and Facilities Costs:
  - The ICE estimate on average assumed a senior engineering team. The cost of occupancy was included in the corporate overhead rate applied to all labor. The overhead also covered utilities, and maintenance.
  - The PCE estimate assumed mix of junior, mid-range pay and high pay staff based on OPM federal pay scales. Facility costs were accounted for separately.
- Regional Asset Costs:
  - The ICE Team used the 11 regional build-out plans as input to the regional associations cost estimate.
  - PCE team did not receive the 11 regional build-out plans. The basis of estimate for regional costs in PCE was based on a synthesis of all the regional build-out plans which did not contain as much detail.
- Federal Agency Contributions
  - The ICE team used a parametric approach combined with inclusion of data received from NOAA and USACE.
  - The PCE team relied upon inputs from federal and non-federal components received via the program office. The PCE team also gathered cost info from publicly available sources resulting in the

largest deviation between the ICE and PCE estimates. The parametric ICE approach was ultimately adopted by the PCE team. The assumptions of the approach were also reviewed and modified during the reconciliation meetings. A revised parametric approach was incorporated by both the ICE and the PCE teams.

- Cost Profile/Ramp Up:
  - The ICE team had access to the 11 Regional Build-out plans, which quantified the number of assets by year for Years 1-10. These numbers were used as stated in the plans.
  - As mentioned above, the PCE team had developed their estimates from a synthesis of the 11 plans. The synthesis captured the number of assets at full operational capability. The PCE team interpreted this as the end state of Year 10 and created a ramp-up over the 10 years to full capability at the synthesis number of assets.

4.3 POST RECONCILIATION DATA

Post reconciliation and incorporation of appropriate changes to both estimates, as of 04/23/2012, the PCE estimate was at $56.4B while the ICE team estimate is at $54.2B, a delta of less than 5%.

Section 5. Cost Risk Assessment and S-Curve

5.1 S-CURVE METHODOLOGY

To meet the objectives stated in the CARD, a probabilistic analysis (S-curve) was performed on the developed 3CV cost estimate. The S-curve provided a sense of how much variability was present in the cost estimates given uncertainties inherent to any cost assessment approach. A probabilistic simulation was used to capture the best and worst-case scenarios of each cost element and uncertainties of the IOOS pertaining to technical design, estimating approach, variability among cost inputs, and other external factors that could augment the overall uncertainty of the cost estimate. The intent of the S-curve was to provide a cost assessment of the program. Primary inputs for this simulation were the minimum, maximum, and most likely costs for each WBS element (see Table 5.1-1). The input estimates assumed full correlation when convolving WBS elements. The S-curve assumptions by Central, Federal, and Non-Federal entities are document in Table 5.1-2.

The resulting S-curve is a blend of all probabilistic cost model estimates into a single common S-curve. As required by the CARD, U.S. IOOS cost estimates are provided at both 50th and 80th percentile confidence levels of the S-curve. Figure 5.1-1 displays the cumulative percentiles for IOOS 3CV cost versus confidence level showing the median value at the fiftieth percentile. Based on the probabilistic distribution, the cost-confidence in the IOOS ICE estimate of $54.2B falls on the 55th percentile of the S-curve, the 50th percentile is at $52.9B and the 80th percentile estimate is at $60.4B.

Table 5.1-1. S-Curve model inputs (Inflated $M).

WBS Elements	Minimum	Most Likely	Maximum
Central Function 1.0	458,911	573,639	745,731
Central Function 2.0	329,636	412,045	535,658
Federal Function 1.0	7,583,017	15,166,034	18,199,241
Federal Function 2.0	15,023,738	30,047,475	36,056,970
Non-Federal Function 1.0	3,545,497	4,431,871	5,318,245
Non-Federal Function 2.0	2,860,195	3,575,243	4,290,292

Table 5.1-2. Assumptions used to determine Minimum, Most Likely, and Maximum values.

Central Function 1.0	Inputs from CARD and JPL DMAC estimate. Grassroots inputs.
Central Function 2.0	Inputs from CARD and JPL DMAC estimate. Grassroots inputs. Not all 2.0 functions are well defined in CARD.
Federal Contribution 1.0	High level assumptions. Estimate likely to overestimate rather than under estimate because all cost associated with the Ocean Division of Geosciences is assumed.
Federal Contribution 2.0	High level assumptions. Estimate likely to overestimate rather than under estimate because all cost associated with the Ocean Division of Geosciences is assumed.
Non-Federal Contribution 1.0	Inputs from RA assessments. Grassroots level inputs.

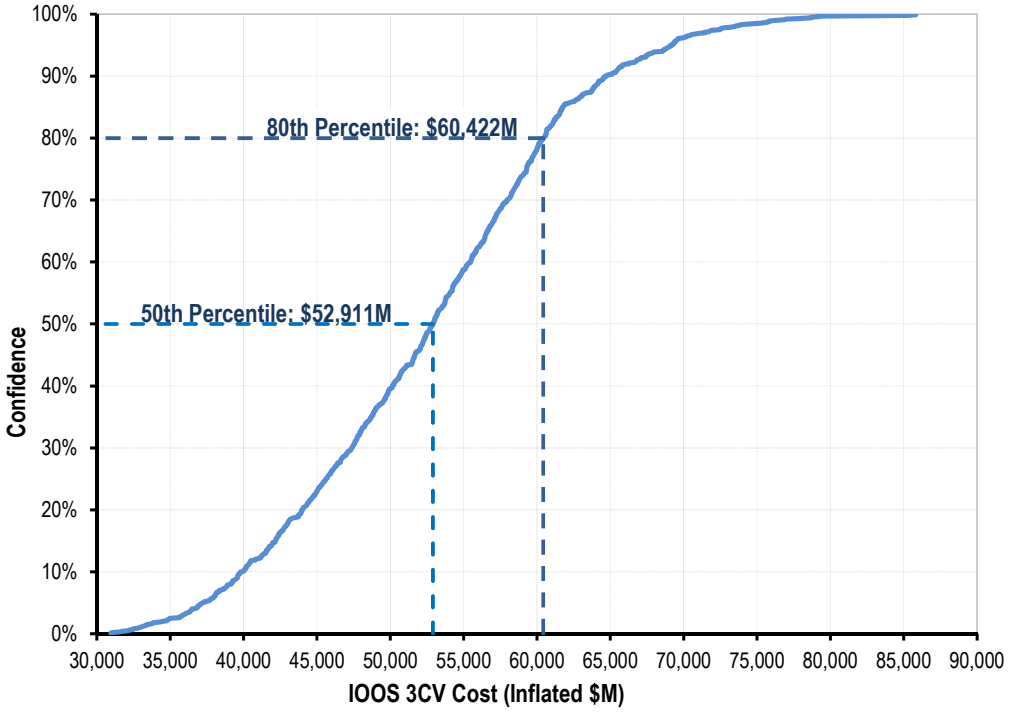


Figure 5.1-1. *IOOS Probabilistic Distribution (S-curve) displaying the 50th and 80th percentile estimates.*

Section 6. Cost Detail

See Tables 6-1 through 6-5 in the subsequent pages of this report for the following cost estimates, breakdowns, and assumptions:

- **Table 6-1:** IOOS workforce by WBS and Central, Federal and Non-Federal functions by year.
- **Table 6-2:** IOOS Cost by WBS and Central, Federal and Non-Federal Functions by year (Inflated $M).
- **Table 6-3:** ICE cost estimates by Non-Federal contributor by year (Inflated $M).
- **Table 6-4:** Parametric assumptions used to derive Federal contribution value by WBS.
- **Table 6-5:** Parametrically derived Federal cost estimates by year (FY2012 Dollars $M).

Table 6-1. IOOS workforce by WBS and Central, Federal and Non-Federal functions by year.

IOOS WBS Element	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Total Work Years
1.0 Development	1,131	1,121	1,135	1,137	1,143	1,144	1,144	1,144	1,144	1,144	-	-	-	-	-	11,386
1.1. Observing subsystems	644	644	645	645	645	645	645	645	645	645	-	-	-	-	-	6,451
Central	2	2	3	3	3	3	3	3	3	3	-	-	-	-	-	28
Federal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Non-Federal	642	642	642	642	642	642	642	642	642	642	-	-	-	-	-	6,423
1.2. Data management and communication (DMAC)	154	154	154	154	154	154	154	154	154	154	-	-	-	-	-	1,536
Central	82	82	82	82	82	82	82	82	82	82	-	-	-	-	-	820
Federal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Non-Federal	72	72	72	72	72	72	72	72	72	72	-	-	-	-	-	716
1.3. Modeling and analysis subsystem	108	109	109	109	109	109	109	109	109	109	-	-	-	-	-	1,087
Central	15	16	16	16	16	16	16	16	16	16	-	-	-	-	-	159
Federal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Non-Federal	93	93	93	93	93	93	93	93	93	93	-	-	-	-	-	928
1.4. Governance and management subsystem	148	148	154	155	160	161	161	161	161	161	-	-	-	-	-	1,571
Central	14	15	21	22	27	28	28	28	28	28	-	-	-	-	-	239
Federal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Non-Federal	134	133	133	133	133	133	133	133	133	133	-	-	-	-	-	1,332
1.5. Research and development subsystem	5	5	9	10	9	9	10	9	9	9	-	-	-	-	-	86
Central	2	2	5	5	5	5	5	5	5	5	-	-	-	-	-	44
Federal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Non-Federal	3	3	4	5	4	4	5	4	4	4	-	-	-	-	-	42
1.6. Training and education subsystem	73	61	64	65	66	66	66	66	66	66	-	-	-	-	-	657
Central	2	4	7	8	9	9	9	9	9	9	-	-	-	-	-	75
Federal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Non-Federal	71	57	57	57	57	57	57	57	57	57	-	-	-	-	-	582
2. Operations and Sustainment	6	7	9	9	11	11	12	12	13	13	1,148	1,146	1,146	1,146	1,146	5,835
2.1. Systems engineering and program management	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	45
Central	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	45

Table 6-1. IOOS workforce by WBS and Central, Federal and Non-Federal functions by year.

IOOS WBS Element	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Total Work Years
Federal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Non-Federal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2.2. System operations [replication of 1.X functions in sustain mode]	1	2	3	3	4	4	4	4	4	4	1,139	1,137	1,137	1,137	1,137	5,720
Central	1	2	3	3	4	4	4	4	4	4	139	137	137	137	137	715
Federal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Non-Federal	-	-	-	-	-	-	-	-	-	-	1,001	1,001	1,001	1,001	1,001	5,004
2.3. Maintenance	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Central	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Federal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Non-Federal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2.4. Sustaining support/engineering	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Central	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Federal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Non-Federal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2.5. Indirect continuing support	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Central	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Federal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Non-Federal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2.6. Continuing system improvements	1	1	2	2	3	3	4	4	5	5	5	5	5	5	5	55
Central	1	1	2	2	3	3	4	4	5	5	5	5	5	5	5	55
Federal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Non-Federal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Work-Years	**1,137**	**1,127**	**1,144**	**1,146**	**1,154**	**1,155**	**1,156**	**1,156**	**1,157**	**1,157**	**1,148**	**1,146**	**1,146**	**1,146**	**1,146**	**17,221**

Table 6-2. IOOS Cost by WBS and Central, Federal and Non-Federal Functions by year (Inflated $M).

IOOS WBS Element	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Total 3CV
1.0 Development	2,166	2,315	2,594	2,439	2,074	1,786	1,653	1,682	1,714	1,749	-	-	-	-	-	20,172
1.1. Observing subsystems	1,279	1,448	1,705	1,531	1,147	841	688	701	714	728	-	-	-	-	-	10,782
Central	0.834	0.849	1	1	1	1	1	1	1	1	-	-	-	-	-	13
Federal	1,007	1,173	1,425	1,245	857	544	387	394	401	409	-	-	-	-	-	7,843
Non-Federal	271	274	279	284	289	296	300	306	311	317	-	-	-	-	-	2,926
1.2. Data management and communication (DMAC)	265	267	273	279	283	289	296	300	306	314	-	-	-	-	-	2,873
Central	32	30	31	33	32	34	36	35	35	38	-	-	-	-	-	337
Federal	210	214	218	222	226	231	235	240	244	249	-	-	-	-	-	2,289
Non-Federal	23	23	24	24	25	25	25	26	26	27	-	-	-	-	-	248
1.3. Modeling and analysis subsystem	245	250	255	260	265	270	275	280	285	291	-	-	-	-	-	2,675
Central	5	6	6	6	6	6	6	6	6	7	-	-	-	-	-	60
Federal	210	214	218	222	226	231	235	240	244	249	-	-	-	-	-	2,289
Non-Federal	30	31	31	32	32	33	34	34	35	35	-	-	-	-	-	327
1.4. Governance and management subsystem	232	206	213	217	224	228	233	237	242	246	-	-	-	-	-	2,279
Central	6	6	9	10	12	13	13	13	14	14	-	-	-	-	-	110
Federal	140	143	145	148	151	154	157	160	163	166	-	-	-	-	-	1,526
Non-Federal	86	57	58	60	61	62	63	64	65	67	-	-	-	-	-	643
1.5. Research and development subsystem	77	78	81	83	85	86	88	90	91	93	-	-	-	-	-	853
Central	0.834	0.849	2	2	2	2	2	2	2	2	-	-	-	-	-	20
Federal	70	71	73	74	75	77	78	80	81	83	-	-	-	-	-	763
Non-Federal	6	6	6	7	7	7	7	7	7	8	-	-	-	-	-	70
1.6. Training and education subsystem	67	64	67	69	70	72	73	74	76	77	-	-	-	-	-	709
Central	0.834	2	3	4	4	4	4	4	4	4	-	-	-	-	-	34
Federal	42	43	44	44	45	46	47	48	49	50	-	-	-	-	-	458
Non-Federal	24	20	20	21	21	21	22	22	23	23	-	-	-	-	-	217
2. Operations and Sustainment	1,781	1,770	1,808	2,057	2,203	2,144	2,136	2,056	2,095	2,112	2,692	2,737	2,787	2,803	2,852	34,035
2.1. Systems engineering and program management	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	21
Central	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	21

Table 6-2. IOOS Cost by WBS and Central, Federal and Non-Federal Functions by year (Inflated $M).

IOOS WBS Element	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Total 3CV
Federal	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Non-Federal	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2.2. System operations [replication of 1.X functions in sustain mode]	916	890	911	1,143	1,271	1,195	1,168	1,070	1,089	1,087	1,647	1,672	1,702	1,697	1,725	19,183
Central	0.417	0.637	1	1	2	2	2	2	2	2	66	66	69	68	69	352
Federal	855	827	846	1,076	1,202	1,124	1,096	997	1,014	1,011	1,023	1,038	1,054	1,039	1,053	15,256
Non-Federal	61	62	64	65	67	69	70	72	73	75	557	568	579	590	602	3,575
2.3. Maintenance	576	586	596	608	619	631	643	656	668	681	695	708	721	735	749	9,872
Central	0.417	0.424	0.432	0.441	0.449	0.458	0.466	0.475	0.484	0.493	2	1	1	1	1	12
Federal	575	585	596	607	619	631	643	655	668	680	693	707	720	734	748	9,861
Non-Federal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2.4. Sustaining support/engineering	144	146	149	152	155	158	161	164	167	170	173	177	180	183	187	2,465
Central	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Federal	144	146	149	152	155	158	161	164	167	170	173	177	180	183	187	2,465
Non-Federal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2.5. Indirect continuing support	72	73	74	76	77	79	80	82	83	85	87	88	90	92	93	1,233
Central	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Federal	72	73	74	76	77	79	80	82	83	85	87	88	90	92	93	1,233
Non-Federal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2.6. Continuing system improvements	72	74	75	77	79	80	82	84	86	88	89	91	93	94	96	1,260
Central	0.417	0.424	0.865	0.881	1	1	2	2	2	2	3	3	3	3	3	27
Federal	72	73	74	76	77	79	80	82	83	85	87	88	90	92	93	1,233
Non-Federal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total 3CV	**3,947**	**4,085**	**4,401**	**4,496**	**4,277**	**3,931**	**3,789**	**3,738**	**3,809**	**3,861**	**2,692**	**2,737**	**2,787**	**2,803**	**2,852**	**54,206**

Table 6-3. ICE cost estimates by Non-Federal contributor by year (Inflated $M).

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Total
ACT	$1	$1	$1	$2	$2	$2	$2	$2	$2	$2	$2	$2	$2	$2	$2	$25
AOOS	$52	$53	$54	$55	$56	$57	$58	$59	$60	$61	$62	$64	$65	$66	$67	$891
CaRa	$14	$14	$15	$15	$15	$16	$16	$17	$17	$17	$18	$18	$18	$19	$19	$248
CeNCOOS	$17	$18	$18	$18	$19	$19	$19	$19	$20	$20	$21	$21	$21	$22	$22	$294
GCOOS	$52	$52	$53	$55	$56	$57	$58	$59	$61	$62	$61	$62	$64	$65	$66	$883
GLOS	$19	$18	$19	$19	$19	$20	$20	$20	$21	$21	$21	$22	$22	$23	$23	$308
MACOORA	$112	$110	$112	$115	$117	$119	$121	$124	$126	$128	$131	$133	$136	$138	$141	$1,864
NANOOS	$36	$36	$37	$38	$38	$39	$40	$40	$41	$42	$43	$44	$44	$45	$46	$609
NERACOOS	$45	$39	$40	$41	$42	$42	$43	$44	$45	$46	$43	$44	$45	$45	$46	$650
PacIOOS	$36	$37	$38	$38	$39	$40	$41	$42	$42	$43	$45	$46	$47	$48	$49	$631
SCCOOS	$47	$24	$24	$25	$25	$27	$26	$27	$27	$28	$28	$28	$29	$30	$30	$424
SECOORA	$69	$70	$71	$73	$74	$76	$77	$79	$80	$82	$83	$85	$86	$88	$90	$1,182
Total ($M)	**$501**	**$474**	**$482**	**$492**	**$502**	**$512**	**$521**	**$531**	**$541**	**$552**	**$557**	**$568**	**$579**	**$590**	**$602**	**$8,007**

Table 6-4. Parametric assumptions used to derive Federal contribution value by WBS.

	Base Cost (FY12$K)	1.1. Observing subsystems	1.2. Data management and communication (DMAC)	1.3. Modeling and analysis subsystem	1.4. Governance and management subsystem	1.5. Research and development subsystem	1.6. Training and education subsystem	2.2. System operations [replication of 1.X functions in sustain mode]	2.3. Maintenance	2.4. Sustaining support/engineering	2.5. Indirect continuing support	2.6 Continuing System Improvements
NOAA	1,480	Direct Input Received	50% * 15%	50% * 15%	50% * 10%	50% * 5%	50% * 3%	Direct Input Received	50% * 40%	50% * 10%	50% * 5%	50% * 5%
USACE	10	Direct Input Received	20% * 15%	20% * 15%	20% * 10%	20% * 5%	20% * 3%	Direct Input Received	80% * 40%	80% * 10%	80% * 5%	80% * 5%
NSF	300	50% * 52%	50% * 15%	50% * 15%	50% * 10%	50% * 5%	50% * 3%	50% * 40%	50% * 40%	50% * 10%	50% * 5%	50% * 5%
NASA	500	80% * 52%	80% * 15%	80% * 15%	80% * 10%	80% * 5%	80% * 3%	20% * 40%	20% * 40%	20% * 10%	20% * 5%	20% * 5%
ONR	500	20% * 52%	20% * 15%	20% * 15%	20% * 10%	20% * 5%	20% * 3%	80% * 40%	80% * 40%	80% * 10%	80% * 5%	80% * 5%
BOEMRE	10	20% * 52%	20% * 15%	20% * 15%	20% * 10%	20% * 5%	20% * 3%	80% * 40%	80% * 40%	80% * 10%	80% * 5%	80% * 5%
USCG	10	20% * 52%	20% * 15%	20% * 15%	20% * 10%	20% * 5%	20% * 3%	80% * 40%	80% * 40%	80% * 10%	80% * 5%	80% * 5%
USGS	10	20% * 52%	20% * 15%	20% * 15%	20% * 10%	20% * 5%	20% * 3%	80% * 40%	80% * 40%	80% * 10%	80% * 5%	80% * 5%
DOE	10	20% * 52%	20% * 15%	20% * 15%	20% * 10%	20% * 5%	20% * 3%	80% * 40%	80% * 40%	80% * 10%	80% * 5%	80% * 5%
EPA	1.25	20% * 52%	20% * 15%	20% * 15%	20% * 10%	20% * 5%	20% * 3%	80% * 40%	80% * 40%	80% * 10%	80% * 5%	80% * 5%
MMC	1.25	20% * 52%	20% * 15%	20% * 15%	20% * 10%	20% * 5%	20% * 3%	80% * 40%	80% * 40%	80% * 10%	80% * 5%	80% * 5%
JCS	1.25	20% * 52%	20% * 15%	20% * 15%	20% * 10%	20% * 5%	20% * 3%	80% * 40%	80% * 40%	80% * 10%	80% * 5%	80% * 5%
CSREES	1.25	20% * 52%	20% * 15%	20% * 15%	20% * 10%	20% * 5%	20% * 3%	80% * 40%	80% * 40%	80% * 10%	80% * 5%	80% * 5%
DOS	1.25	20% * 52%	20% * 15%	20% * 15%	20% * 10%	20% * 5%	20% * 3%	80% * 40%	80% * 40%	80% * 10%	80% * 5%	80% * 5%
DOT	1.25	20% * 52%	20% * 15%	20% * 15%	20% * 10%	20% * 5%	20% * 3%	80% * 40%	80% * 40%	80% * 10%	80% * 5%	80% * 5%
FDA	1.25	20% * 52%	20% * 15%	20% * 15%	20% * 10%	20% * 5%	20% * 3%	80% * 40%	80% * 40%	80% * 10%	80% * 5%	80% * 5%
USARC	1.25	20% * 52%	20% * 15%	20% * 15%	20% * 10%	20% * 5%	20% * 3%	80% * 40%	80% * 40%	80% * 10%	80% * 5%	80% * 5%

Table 6-5. Parametrically derived Federal cost estimates by year (FY2012 Dollars $M).

WBS Element	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Total
1.1.4 Federal Input																
NOAA	664	810	1,032	836	453	153	3	2	2	2	-	-	-	-	-	3,955
USACE	0.282	0.53	0.33	0.341	0.352	0.363	0.374	0.385	0.396	0.37	-	-	-	-	-	4
NSF	78	78	78	78	78	78	78	78	78	78	-	-	-	-	-	780
NASA	208	208	208	208	208	208	208	208	208	208	-	-	-	-	-	2,080
ONR	52	52	52	52	52	52	52	52	52	52	-	-	-	-	-	520
BOEMRE	1	1	1	1	1	1	1	1	1	1	-	-	-	-	-	10
USCG	1	1	1	1	1	1	1	1	1	1	-	-	-	-	-	10
USGS	1	1	1	1	1	1	1	1	1	1	-	-	-	-	-	10
DOE	1	1	1	1	1	1	1	1	1	1	-	-	-	-	-	10
EPA	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	-	-	-	-	-	1
MMC	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	-	-	-	-	-	1
JCS	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	-	-	-	-	-	1
CSREES	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	-	-	-	-	-	1
DOS	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	-	-	-	-	-	1
DOT	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	-	-	-	-	-	1
FDA	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	-	-	-	-	-	1
USARC	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	-	-	-	-	-	1
1.2. Federal Input	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOAA	111	111	111	111	111	111	111	111	111	111	-	-	-	-	-	1,110
USACE	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	-	-	-	-	-	3
NSF	23	23	23	23	23	23	23	23	23	23	-	-	-	-	-	225
NASA	60	60	60	60	60	60	60	60	60	60	-	-	-	-	-	600
ONR	15	15	15	15	15	15	15	15	15	15	-	-	-	-	-	150
BOEMRE	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	-	-	-	-	-	3
USCG	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	-	-	-	-	-	3
USGS	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	-	-	-	-	-	3
DOE	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	-	-	-	-	-	3
EPA	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	-	-	-	-	-	0.375
MMC	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	-	-	-	-	-	0.375
JCS	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	-	-	-	-	-	0.375
CSREES	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	-	-	-	-	-	0.375
DOS	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	-	-	-	-	-	0.375
DOT	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	-	-	-	-	-	0.375
FDA	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	-	-	-	-	-	0.375
USARC	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	-	-	-	-	-	0.375

Table 6-5. Parametrically derived Federal cost estimates by year (FY2012 Dollars $M).

WBS Element	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Total
1.3 Federal Input	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOAA	111	111	111	111	111	111	111	111	111	111	-	-	-	-	-	1,110
USACE	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	-	-	-	-	-	3
NSF	23	23	23	23	23	23	23	23	23	23	-	-	-	-	-	225
NASA	60	60	60	60	60	60	60	60	60	60	-	-	-	-	-	600
ONR	15	15	15	15	15	15	15	15	15	15	-	-	-	-	-	150
BOEMRE	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	-	-	-	-	-	3
USCG	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	-	-	-	-	-	3
USGS	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	-	-	-	-	-	3
DOE	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	-	-	-	-	-	3
EPA	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	-	-	-	-	-	0.375
MMC	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	-	-	-	-	-	0.375
JCS	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	-	-	-	-	-	0.375
CSREES	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	-	-	-	-	-	0.375
DOS	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	-	-	-	-	-	0.375
DOT	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	-	-	-	-	-	0.375
FDA	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	-	-	-	-	-	0.375
USARC	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	-	-	-	-	-	0.375
1.4 Federal Input	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOAA	74	74	74	74	74	74	74	74	74	74	-	-	-	-	-	740
USACE	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	-	-	-	-	-	2
NSF	15	15	15	15	15	15	15	15	15	15	-	-	-	-	-	150
NASA	40	40	40	40	40	40	40	40	40	40	-	-	-	-	-	400
ONR	10	10	10	10	10	10	10	10	10	10	-	-	-	-	-	100
BOEMRE	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	-	-	-	-	-	2
USCG	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	-	-	-	-	-	2
USGS	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	-	-	-	-	-	2
DOE	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	-	-	-	-	-	2
EPA	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	-	-	-	-	-	0.25
MMC	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	-	-	-	-	-	0.25
JCS	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	-	-	-	-	-	0.25
CSREES	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	-	-	-	-	-	0.25
DOS	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	-	-	-	-	-	0.25
DOT	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	-	-	-	-	-	0.25
FDA	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	-	-	-	-	-	0.25
USARC	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	-	-	-	-	-	0.25

Table 6-5. Parametrically derived Federal cost estimates by year (FY2012 Dollars $M).

WBS Element	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Total
1.5 Federal Input	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOAA	37	37	37	37	37	37	37	37	37	37	-	-	-	-	-	370
USACE	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-	-	-	-	-	1
NSF	8	8	8	8	8	8	8	8	8	8	-	-	-	-	-	75
NASA	20	20	20	20	20	20	20	20	20	20	-	-	-	-	-	200
ONR	5	5	5	5	5	5	5	5	5	5	-	-	-	-	-	50
BOEMRE	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-	-	-	-	-	1
USCG	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-	-	-	-	-	1
USGS	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-	-	-	-	-	1
DOE	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-	-	-	-	-	1
EPA	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	-	-	-	-	-	0.125
MMC	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	-	-	-	-	-	0.125
JCS	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	-	-	-	-	-	0.125
CSREES	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	-	-	-	-	-	0.125
DOS	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	-	-	-	-	-	0.125
DOT	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	-	-	-	-	-	0.125
FDA	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	-	-	-	-	-	0.125
USARC	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	-	-	-	-	-	0.125
1.6 Federal Input	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOAA	22	22	22	22	22	22	22	22	22	22	-	-	-	-	-	222
USACE	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	-	-	-	-	-	0.6
NSF	5	5	5	5	5	5	5	5	5	5	-	-	-	-	-	45
NASA	12	12	12	12	12	12	12	12	12	12	-	-	-	-	-	120
ONR	3	3	3	3	3	3	3	3	3	3	-	-	-	-	-	30
BOEMRE	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	-	-	-	-	-	0.6
USCG	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	-	-	-	-	-	0.6
USGS	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	-	-	-	-	-	0.6
DOE	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	-	-	-	-	-	0.6
EPA	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	-	-	-	-	-	0.075
MMC	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	-	-	-	-	-	0.075
JCS	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	-	-	-	-	-	0.075
CSREES	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	-	-	-	-	-	0.075
DOS	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	-	-	-	-	-	0.075
DOT	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	-	-	-	-	-	0.075
FDA	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	-	-	-	-	-	0.075
USARC	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	-	-	-	-	-	0.075

Table 6-5. Parametrically derived Federal cost estimates by year (FY2012 Dollars $M).

WBS Element	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Total
Federal Input for WBS 1 Roll-Up Total:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOAA	1,019	1,165	1,387	1,191	808	508	358	357	357	357	-	-	-	-	-	7,507
USACE	1	1	1	1	1	1	1	1	1	1	-	-	-	-	-	13
NSF	150	150	150	150	150	150	150	150	150	150	-	-	-	-	-	1,500
NASA	400	400	400	400	400	400	400	400	400	400	-	-	-	-	-	4,000
ONR	100	100	100	100	100	100	100	100	100	100	-	-	-	-	-	1,000
BOEMRE	2	2	2	2	2	2	2	2	2	2	-	-	-	-	-	20
USCG	2	2	2	2	2	2	2	2	2	2	-	-	-	-	-	20
USGS	2	2	2	2	2	2	2	2	2	2	-	-	-	-	-	20
DOE	2	2	2	2	2	2	2	2	2	2	-	-	-	-	-	20
EPA	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	-	-	-	-	-	3
MMC	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	-	-	-	-	-	3
JCS	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	-	-	-	-	-	3
CSREES	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	-	-	-	-	-	3
DOS	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	-	-	-	-	-	3
DOT	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	-	-	-	-	-	3
FDA	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	-	-	-	-	-	3
USARC	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	-	-	-	-	-	3
2.2 Federal Input	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
NOAA	571	529	528	731	829	739	694	588	587	568	561	557	554	526	522	9,083
USACE	8	8	12	12	12	11	11	11	11	11	12	12	12	12	12	168
NSF	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	900
NASA	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	600
ONR	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	2,400
BOEMRE	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	48
USCG	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	48
USGS	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	48
DOE	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	48
EPA	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	6
MMC	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	6
JCS	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	6
CSREES	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	6
DOS	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	6
DOT	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	6
FDA	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	6

Table 6-5. Parametrically derived Federal cost estimates by year (FY2012 Dollars $M).

WBS Element	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Total
USARC	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	6
2.3 Federal Input	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
NOAA	296	296	296	296	296	296	296	296	296	296	296	296	296	296	296	4,440
USACE	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	48
NSF	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	900
NASA	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	600
ONR	160	160	160	160	160	160	160	160	160	160	160	160	160	160	160	2,400
BOEMRE	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	48
USCG	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	48
USGS	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	48
DOE	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	48
EPA	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	6
MMC	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	6
JCS	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	6
CSREES	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	6
DOS	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	6
DOT	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	6
FDA	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	6
USARC	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	6
2.4 Federal Input	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
NOAA	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	1,110
USACE	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	12
NSF	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	225
NASA	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	150
ONR	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	600
BOEMRE	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	12
USCG	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	12
USGS	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	12
DOE	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	12
EPA	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	2
MMC	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	2
JCS	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	2
CSREES	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	2
DOS	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	2
DOT	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	2
FDA	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	2

Table 6-5. Parametrically derived Federal cost estimates by year (FY2012 Dollars $M).

WBS Element	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Total
USARC	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	2
2.5 Federal Input	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
NOAA	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	555
USACE	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	6
NSF	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	113
NASA	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	75
ONR	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	300
BOEMRE	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	6
USCG	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	6
USGS	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	6
DOE	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	6
EPA	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.75
MMC	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.75
JCS	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.75
CSREES	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.75
DOS	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.75
DOT	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.75
FDA	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.75
USARC	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.75
2.6 Federal Input	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
NOAA	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	555
USACE	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	6
NSF	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	113
NASA	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	75
ONR	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	300
BOEMRE	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	6
USCG	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	6
USGS	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	6
DOE	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	6
EPA	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.75
MMC	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.75
JCS	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.75
CSREES	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.75
DOS	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.75
DOT	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.75
FDA	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.75

Table 6-5. Parametrically derived Federal cost estimates by year (FY2012 Dollars $M).

WBS Element	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Total
USARC	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.75
Federal Input for WBS 2 Roll-Up Total:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
NOAA	1,015	973	972	1,175	1,273	1,183	1,138	1,032	1,031	1,012	1,005	1,001	998	970	966	15,743
USACE	13	13	17	17	17	15	15	16	16	16	17	17	17	17	17	240
NSF	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	2,250
NASA	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	1,500
ONR	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	6,000
BOEMRE	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	120
USCG	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	120
USGS	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	120
DOE	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	120
EPA	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
MMC	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
JCS	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
CSREES	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
DOS	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
DOT	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
FDA	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
USARC	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Federal Input Total:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
NOAA	2,034	2,138	2,359	2,366	2,080	1,690	1,496	1,390	1,388	1,369	1,005	1,001	998	970	966	23,251
USACE	14	15	18	19	19	17	17	17	17	17	17	17	17	17	17	253
NSF	300	300	300	300	300	300	300	300	300	300	150	150	150	150	150	3,750
NASA	500	500	500	500	500	500	500	500	500	500	100	100	100	100	100	5,500
ONR	500	500	500	500	500	500	500	500	500	500	400	400	400	400	400	7,000
BOEMRE	10	10	10	10	10	10	10	10	10	10	8	8	8	8	8	140
USCG	10	10	10	10	10	10	10	10	10	10	8	8	8	8	8	140
USGS	10	10	10	10	10	10	10	10	10	10	8	8	8	8	8	140
DOE	10	10	10	10	10	10	10	10	10	10	8	8	8	8	8	140
EPA	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	18
MMC	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	18
JCS	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	18
CSREES	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	18
DOS	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	18
DOT	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	18

Table 6-5. Parametrically derived Federal cost estimates by year (FY2012 Dollars $M).

WBS Element	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Total
FDA	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	18
USARC	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	18
Total (FY12)	**3,398**	**3,502**	**3,728**	**3,734**	**3,449**	**3,057**	**2,863**	**2,756**	**2,755**	**2,736**	**1,712**	**1,708**	**1,705**	**1,677**	**1,673**	**40,454**
Total (inflated)	**3,398**	**3,563**	**3,863**	**3,944**	**3,712**	**3,353**	**3,200**	**3,139**	**3,197**	**3,236**	**2,063**	**2,098**	**2,134**	**2,139**	**2,175**	**45,214**

Section 7. Appendices

7.1 IOOS Central DMAC Architecture Description

7.1.1 Provenance

The Data Management and Communications (DMAC) subsystem architecture is derived in the greatest part from the requirements in the IOOS High-Level Functional Requirements document, Version 1.5, January 2009. The requirements show mapping to a particular architectural component or service in a trace matrix in Section 9.4.5 of this document.

It takes as advisory any architecture-related "should" statements in the requirements document, including but not limited to:

> *"The IOOS design should not depend on a specific technology of implementation for its architecture." —Chapter 1.*

It implements to the extent practicable the architecture-specific "shall" statement in Chapter 3, Design Principles.

> *"The IOOS shall comply with the OMB Federal Enterprise Architecture (FEA) Data Reference Model (DRM)."*

The FEA DRM is interpreted to be the most recent version at its official URL.

http://www.whitehouse.gov/sites/default/files/omb/assets/egov_docs/DRM_2_0_Final.pdf

The architecture also conforms to the FEA Technical Reference Model (TRM) and appropriate sections of the Performance Reference Model (PRM), Business Reference Model (BRM) and Service Component Reference Model (SRM).

It conforms to the introduction of the Data Services section of the requirements document with respect to the "will" statement regarding the FEA DRM but has not evaluated the effect of the parenthetical clause stating "per the NOAA Enterprise Architecture, version 3.0," as that document requires authenticated access through the following link.

https://secure.cio.noaa.gov/noaa_cio_EA_documentation.html

To the extent that it does not conflict with the requirements, the architecture conforms to the guidance in appropriate sections of the U.S. Integrated Ocean Observing System: A Blueprint for Full Capacity, Version 1.0, U.S. IOOS Office, November 2010.

In addition, the architecture was reviewed and confirmed at JPL by senior engineers and architects representing NASA's Planetary Data System (PDS) and Physical Oceanography Distributed Active Archive Center (PO.DAAC).

7.1.2 High-Level Architecture and Components

- DMAC places the data holdings of the DACs at the fingertips of the users and enhances the value of the data with modeling and analysis.
- The DMAC catalogs data holdings from Federal and Regional DACs.
- The DMAC, though its web Portal Services, provides users with both simple and advanced catalog search services.
- The DMAC provides the user with the ability to request and receive data from across all of its cataloged repositories.
- The DMAC provides a user the capability to run both DAC-originated models and sponsored models with integrated data using IOOS processing resources and with the facilitation of IOOS Modeling and Analysis scientists and staff.
- The DMAC performs Customer Relationship Management (CRM), information dissemination and educational functions across a broad spectrum from science user, to general public to Government agency.
- The DMAC extends its utility by providing web services that access all of its major functionality for users that require interoperable machine-to-machine interaction over the Internet.
- The DMAC implements substantial Quality Control (QC) across all of its processes.
- It is the "one-stop shop" for the U.S. IOOS, its data and services.

The DMAC high-level architecture and components are represented in Figure 7.1.2-1.

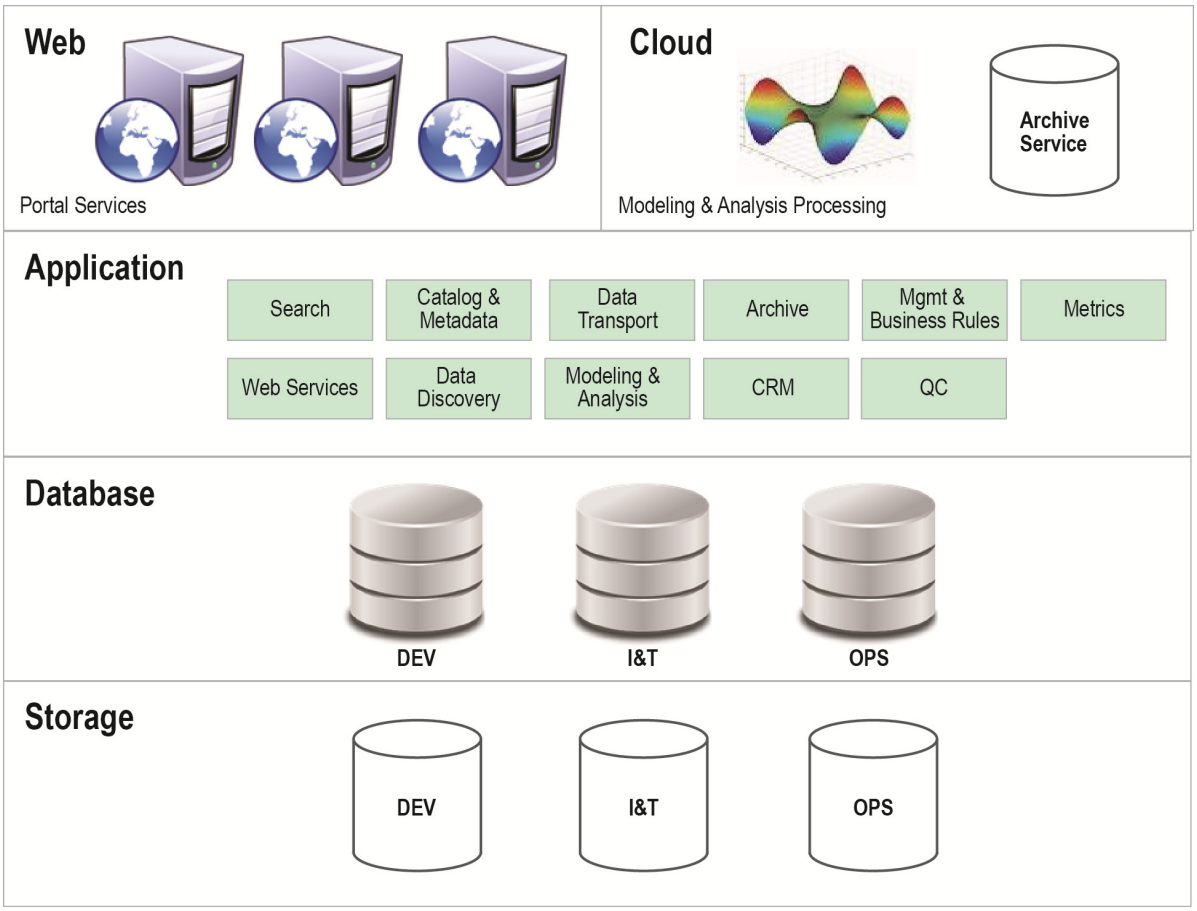


Figure 7.1.2-1. *DMAC high-level architecture.*

7.1.2.1 System Boundaries

The system is physically contained within the Web Services, Applications, Database and Storage Components, which are nominally co-located within a physical data center. The architecture has a virtual extension into the Cloud for Modeling and Analysis Processing (an on-demand service) and the Archive Service (a persistent service).

7.1.2.2 External Interfaces

The DMAC has eight external interfaces

1. Public Internet—Portal Services: User Interface.
2. Public Internet—Cloud: Modeling and Analysis Processing.
3. Public Internet—Cloud: Archive Service.
4. Public Internet—Federal and Regional DACs: Data Discovery.
5. Public Internet—Federal and Regional DACs: Data Transport.
6. Public Internet—Data Transport: Users.
7. Public Internet—User systems: Web Services.
8. Public Internet—CRM: User interactions (e-mail, etc.).

7.1.3 Component Description and Mapping

7.1.3.1 Application

7.1.3.1.1 Search (SRM—763)

- This is a conventional search engine providing both simple and advanced search.
- It provides an interface to the Portal Services.
- It uses standard IOOS metadata.
- Its repository is provided by the Catalog and Metadata function.

7.1.3.1.2 Catalog and Metadata (TRM, DRM)

- This is a search engine catalog and index.
- It uses standard IOOS metadata.
- It is updated by the Data Discovery function.
- Its tables physically reside in the database.

7.1.3.1.3 Data Discovery (SRM, DRM)

- This function interrogates the subscribed remote data sources for new, changed or deleted data holdings.
- It converts data received from the interrogation into the IOOS metadata standard.
- It populates/updates the Catalog and Metadata function.

7.1.3.1.4 Data Transport (TRM, DRM, SRM)

- This function retrieves user-selected data sets from the source repository/repositories.
- It delivers data sets to the user.
- It delivers data sets to the Modeling and Analysis function.

7.1.3.1.5 Modeling and Analysis (SRM - 743)

- This function interprets modeling and analysis requests from the Portal Services.
- It receives required data from the Data Transport function.
- It retrieves model(s) from the user and /or the model repository.
- It delivers data and model input into the Modeling and Analysis processor.
- It notifies users of results via the Portal Services.
- It triggers the Archive Function in the event that the product meets the "irreplaceable data" criteria held in the Management and Business Rules function.

7.1.3.1.6 Archive (TRM)

- This function stores irreplaceable data (e.g., M&A products) in the Archive Service.
- It maintains a searchable record of the Archive holdings in the database.
- It retrieves a copy of the data from the archive in response to a request from the Portal Services.

7.1.3.1.7 Web Services (TRM)

- This function provides for communication with approved external systems (machine-to-machine) so they can safely access appropriate internal DMAC functionality via the Internet without the use of a UI.
- The interface is described in a machine-accessible format.

7.1.3.1.8 Customer Relationship Management (SRM)

- This function handles electronic user interaction including but not limited to:
  - Support tickets.
  - Informational e-mail outreach.
  - Knowledgebase FAQs.
  - Social media.
  - Informational video.
  - Collaboration.
  - Computer-Based Training (CBT).
- This function integrates with the Portal Services and the Database.

7.1.3.1.9 Management and Business Rules (BRM)

- This function provides policy and control for the system and its workflow.
  - For example, it determines what are irreplaceable data for archiving and determines priorities for M&A processing.
- This function resides in the Database.

7.1.3.1.10 Quality Control (DRM)

- This function analyzes, measures, and reports on the quality of the data discovered in the remote repositories.
- This function analyzes, measures, and reports on the quality of the data encountered by the Data Transport function.
- This function analyzes, measures, and reports on the quality of the data produced by the M&A function.
- This function analyzes, measures, and reports on the quality of the data in the Database.
- This function analyzes, measures, and reports on the quality of the data in

the Archive.

7.1.3.1.11 Metrics (SRM, TRM)

- This function collects and reports on all metrics set by the Management and Business Rules function.
- This function resides in the Database.
- This function is visible through the Portal Services, depending on user role (un-authenticated user, authenticated user, admin, management, etc.).

7.1.3.2 Database

- This function includes all the Oracle relational databases.

7.1.3.3 Web

7.1.3.3.1 Portal Services (TRM, SRM)

- This function is the web portal for the system.
- It has both authenticated and un-authenticated views
- It integrates the UI for Search, M&A, CRM and Metrics

7.1.3.4 Cloud

7.1.3.4.1 Modeling and Analysis Processing (TRM)

- Cloud Services provide the hosting and compute capacity services for the M&A processing.

7.1.3.4.2 Archive Service (TRM, DRM)

- Cloud Services provide the storage capacity for the Archive Function.

7.1.4 Storage (TRM)

- This disk storage supports all DEV, I&T and PROD services for internal and external use.

7.1.5 Major Scenarios and Flows

7.1.5.1 Data Discovery

The data discovery function will support the identification of interesting data across the IOOS enterprise. Data discovery works hand-in-hand with search infrastructure. A typical scenario is a user will execute a (temporal, geospatial) search, locate data set(s) of interest, and then perform granular searching/filtering, often called "mining", of the data. This may entail pulling data from multiple sources that are collected that will be necessary for further analysis.

The discovery function will execute locally based on periods and policy within the Management and Business Rules or it can be executed remotely. Interrogation results are translated into IOOS standard metadata format and checked for quality. If the QC checks pass then the data is passed to the Catalog and Metadata function for the appropriate action(s) in the database (insert, update or delete). Software tools, built on external software and hardware infrastructures that are optimized towards mining massive amounts of data, will be capable of integrating with IOOS through standard software service APIs.

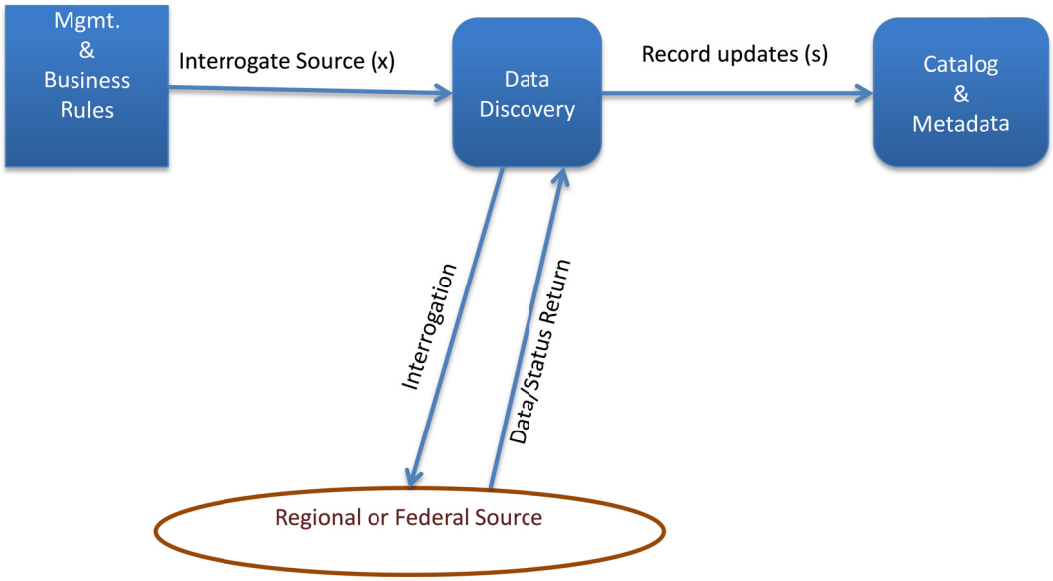


Figure 7.1.5.1-1: *Data Discovery flow.*

7.1.5.2 Search

The Search Services function will employ modern search technologies for locating scientific and other information within the IOOS enterprise. A typical scenario is a user browses to the Portal Services home page to search for and locate information.

The user will be presented with multiple methods to search for data including text-based, facet-based, and geospatial searching mechanisms. Text-based searching employs a Google-like search based on text phrases in the metadata. Facet-based navigation will take advantage of the classification in the captured metadata to create bins which allow a user to drill down into the information. Finally, a geospatial search will allow users to explore the data on a map.

The infrastructure will be explicitly decoupled from the data management infrastructure (Archive, Catalog & Metadata) to allow new search advances to be integrated. The Portal Services themselves will be integrated with the IOOS search infrastructure. The search infrastructure will extract information from repositories, construct indexes and optimize searching of massive scientific data sets and granular data scaling the infrastructure up to billions of tuples. The search index will be constructed on a regular basis from the Catalog & Metadata function and provide extremely fast response for users who are familiar with common conventions already deployed on popular websites.

In addition to the standard browser-based search interface, Search will provide a web service interface for machine-to-machine data exchange. This allows users to develop applications/services using data hosted on IOOS.

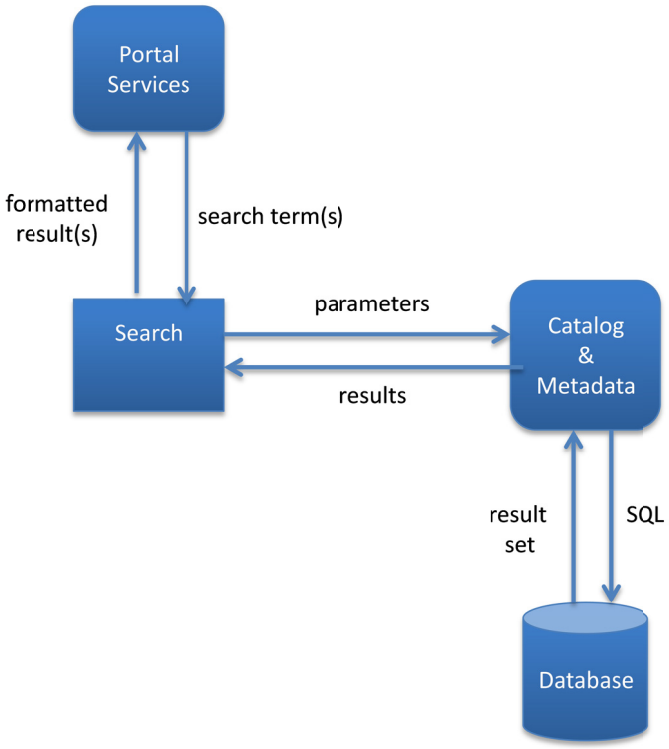


Figure 7.1.5.2-1: *Search flow.*

7.1.5.3 Modeling and Analysis

The Modeling and Analysis function enables modelers and analysts to access services within IOOS to support model development and evaluation. It is anticipated that model validation and intercomparison will be of prime importance, such as we see in the Coupled Model Intercomparison Project (CMIP) {http://cmip-pcmdi.llnl.gov/}. Intercomparison may occur by leveraging model output and observational measurements.

A typical scenario is a user interested in obtaining the output of a model. The user will be able to navigate to the Portal Services, search for the model output and download the data. Data, in this case, could be stored at a local agency or within the cloud. Users will be directed to download the data. High speed Data Transport mechanisms will be employed to move the data for analysis.

Additional scenarios will include the ability to visualize model data, fuse model data with other data, publish model output, execute models, and perform other compute-intensive tasks for generation and intercomparison of models and observational data. Metadata produced will be delivered to the Catalog & Metadata function to improve future Data Discovery and Search functions.

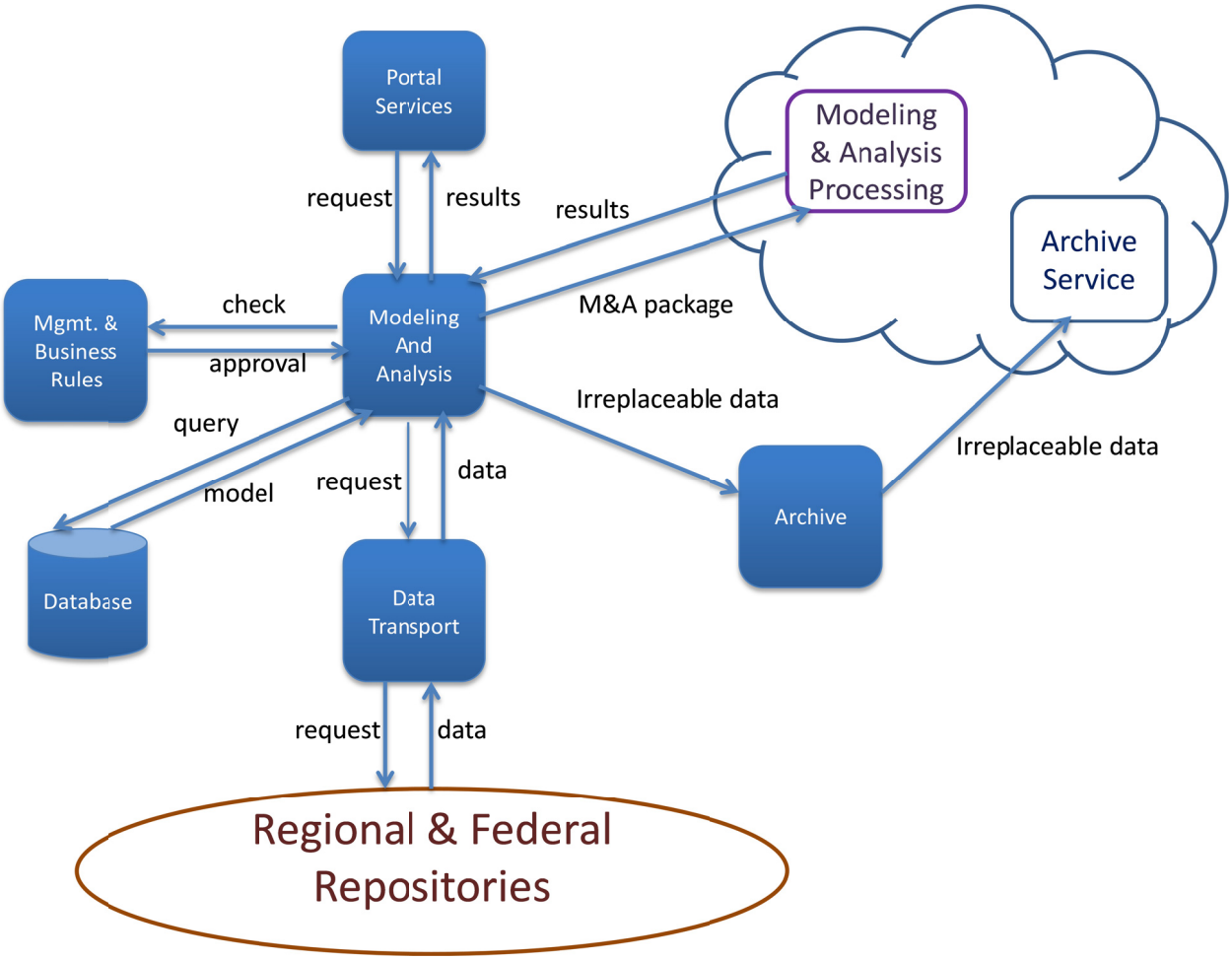


Figure 7.1.5.3-1: *Modeling and Analysis flow.*

7.1.5.4 Data Transport

A typical scenario is a user selecting to receive data after analyzing search results. The Search function places a request with the Data Transport function and the Data Transport function makes data requests of the appropriate repository/repositories. Upon receiving the requested data, the Data Transport function provides the data to the user through the Portal Services.

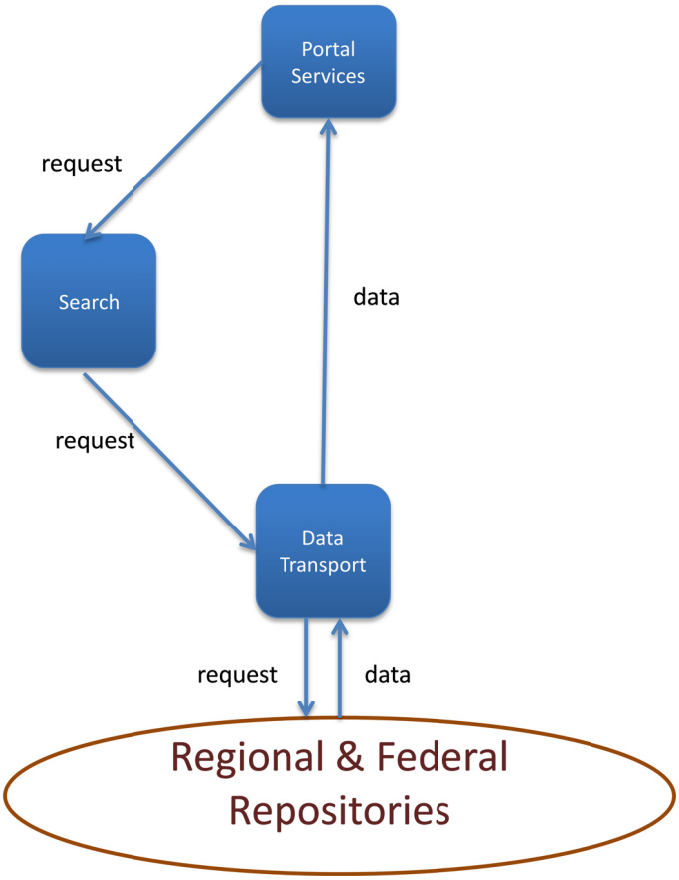


Figure 7.1.5.4-1: *Data Transport flow.*

7.1.5.5 Archive

A typical scenario is a user selecting to retrieve data in the Archive based on a search of the archive holdings. The Archive function retrieves the selected data from the Archive Service and presents it to the user via the Portal Services.

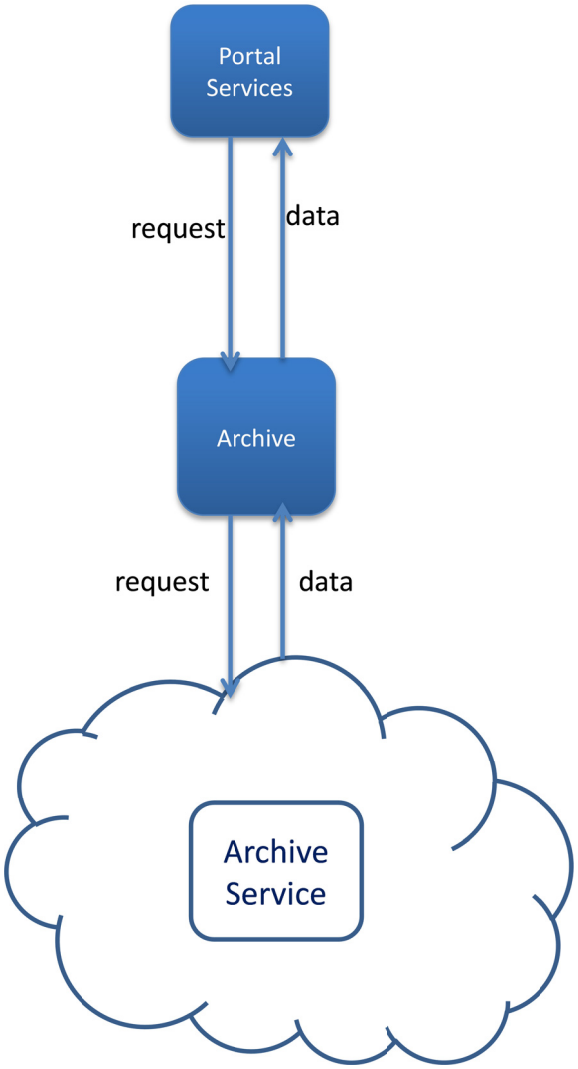


Figure 7.1.5.5-1: *Archive flow.*

7.1.6 DMAC Requirements Mapping

7.1.6.1 System Design

Table 7.1.6.1-1 contains the requirements that address the design, implementation and security of IOOS and its subsystems.

7.1.6.2 Data Collection

Table 7.1.6.2-1 contains the requirements that pertain to data quality control, management, and access.

7.1.6.3 Metadata Management

Table 7.1.6.3-1 contains the requirements that pertain to the way metadata is handled in IOOS and its various subsystems and interfaces.

7.1.6.4 Data Archive

Table 7.1.6.4-1 contains the requirements that pertain to short- and long-term data archiving and to data maintenance. These requirements include guidelines for data retention, data preservation, data catalog services, and data access permissions.

7.1.6.5 Data Services

IOOS data descriptions and exchange requirements will comply with the OMB Federal Enterprise Architecture (FEA) Data Reference Model (DRM) (per the NOAA Enterprise Architecture, version 3.0). Table 7.1.6.5-1 contains the requirements that pertain to data transport and delivery, data discovery and searches, data availability, data transmission, data aggregation, and data translation.

7.1.6.6 Standards and Interoperability

Table 7.1.6.6-1 contains the requirements that pertain to data standards applicable to IOOS and the various subsystems, data integration and linkage on system interoperability and monitoring.

7.1.6.7 Portal Services

Table 7.1.6.7-1 contains the requirements that pertain to the service components of the portal, including education, short- and long-term forecasts for ocean water and weather, ocean observing data, and the IOOS main home page.

7.1.6.8 Observing and Sensor/Data Acquisition Services

Table 7.1.6.8-1 contains the requirements that pertain to the acquisition of IOOS and subsystems core variables and other observations.

7.1.6.9 Research and Education Services

Table 7.1.6.9-1 contains the requirements that pertain to research and education services.

7.1.6.10 Administrative Services

Table 7.1.6.10-1 contains the requirements that address system administrative duties.

7.1.6.11 NOAA

Table 7.1.6.11-1 contains NOAA high-level requirements that are either DIF specific or extracted from the NOAA Strategic Plan.

7.1.6.12 GEOSS, GOOS and IEOS

Table 7.1.6.12-1 contains high-level GEOSS, GOOS and IEOS system requirements.

Table 7.1.6.1-1. System Design.

Identifier	Description	Subsystem	Reference	ICE Allocation/Notes
4.1.1	The DMAC shall offer a cross-language and cross-platform data access mechanism that is independent of the data repository.	DMAC	15. DMAC Plan p. 70, No. 6.1.9	Web Services
4.1.2	The DMAC shall provide a backward-compatible, version controlled software environment.	DMAC	15. DMAC Plan p. 69, No. 6.1.6	Requirement Unclear
4.1.3	Essential functions shall include constant monitoring of data streams, accounting for all files and records, and frequent checks of accuracy.	DMAC	15. DMAC Plan p. 81, No. 2.5.3	QC
4.1.4	The archiving and access service shall maintain, in perpetuity, two copies of irreplaceable data in separate archive centers that are under independent data management. One facility will be designated as the primary archive center for a particular data set, and the other as the secondary archive center. The primary and secondary archive centers storing irreplaceable data may operate as mirror sites, both offering the same level of access, or one as the exclusive access center and the other as a "deep" back-up center (e.g., a regional data center could serve as a secondary archive center).	DMAC	15. DMAC Plan p. 84-85, No. 6.3.1.1, 6.3.1.2, 6.3.1.3, 6.3.1.4	Archive
4.1.5	The archiving and access service shall provide a facility to collect broad-use metrics to evaluate the system effectiveness and gain a sense of how to improve it. Metrics shall include the following as a minimum: • Number of "users." The anonymous nature of much of the access prevents the true number of users from being collected. • Number of accesses. This is the number of files downloaded or otherwise accessed through the various services. Note that volume of data is not used here; a cornerstone of DMAC data access is to provide subsets, GIS maps, online analyses—in short, only the information required by the user. The data access metric shall also be broken down by data set and service method. • System performance statistics. This includes use of disks and computers as well as work performed (services executed and volume accessed). All archive systems shall have a means of soliciting and capturing user feedback on services and data sets.	DMAC	15. DMAC Plan p. 88, No. 7.9.3, 7.9.3.1, 7.9.3.2, 7.9.3.3, 7.9.3.4.1	Archive
4.1.6	The archiving and access service shall provide for measurements of qualitative access.	DMAC	15. DMAC Plan p. 88, No. 7.9.3.4	Archive
4.1.7	The archiving and access service shall be a distributed system of interconnected archive and data centers that function collaboratively to receive and preserve the data and to provide easy and efficient access to the data.	DMAC	15. DMAC Plan p. 209	Archive
4.1.8	Archive centers shall acquire, preserve, and provide access to IOOS data in perpetuity.	DMAC	15. DMAC Plan p. 81, No. 2.5.1	Archive
4.1.9	The data transport service shall be designed and developed to accommodate distributed data storage.	DMAC	15. DMAC Plan p. 78, No. 4.3.2.2	Data Transport

Table 7.1.6.1-1. System Design.

Identifier	Description	Subsystem	Reference	ICE Allocation/Notes
4.1.10	The data transport service shall be designed and developed to accommodate data that resides with the data collector.	DMAC	15. DMAC Plan p. 78, No. 4.3.2.3	Data Transport
4.1.11	The data transport service shall be able to express the structure of the numeric data it will encounter in oceanographic data repositories.	DMAC	15. DMAC Plan p. 162	Data Transport
4.1.12	The data transport service shall be modular, allowing use of capabilities over alternative transport protocols to HTTP.	DMAC	15. DMAC Plan p. 77, No. 3.1	Data Transport
4.1.13	The structure layer protocol of the data transport service shall define the organization of like data objects in a data set.	DMAC	15. DMAC Plan p.77, No. 3.3.1	Data Transport
4.1.14	Operations, and the associated modules in the structure layer of the data transport service, that are discipline neutral shall be logically separated from those that require a semantic understanding of the data.	DMAC	15. DMAC Plan p. 77, No. 3.3.2	Data Transport
4.1.15	The initial DMAC shall use the Open Source Project for a Network Data Access Protocol (OPeNDAP).	DMAC	15. DMAC Plan p. 284	Data Transport
4.1.16	The data transport service shall display, for each data set it contains, the approximate size of the data set selected.	DMAC	15. DMAC Plan p. 78, No. 4.6	Data Transport
4.1.17	The data transport service shall support fault detection and localization within the DMAC.	DMAC	15. DMAC Plan p. 79, No. 4.10	Data Transport
4.1.17.1	The DMAC shall provide oversight mechanisms, including fault detection and correction, to ensure the proper functioning and smooth evolution of IOOS.	DMAC	15. DMAC Plan p. 67, No. 2.9	QC
4.1.17.2	The DMAC shall provide oversight mechanisms, including monitoring and evaluation of system performance, to ensure the proper functioning and smooth evolution of IOOS.	DMAC	15. DMAC Plan p. 67, No. 2.9	QC
4.1.17.3	The DMAC shall provide oversight fault detection and correction mechanisms, including provisions for system extensibility, to ensure the proper functioning and smooth evolution of IOOS.	DMAC	15. DMAC Plan p. 67, No. 2.9	Clause 1: Requirement Unclear, Clause 2: accepted but not allocated.
4.1.17.4	The DMAC shall provide performance monitoring and oversight evaluation mechanisms, including establishing and maintaining international linkages, to ensure the proper functioning and smooth evolution of IOOS.	DMAC	15. DMAC Plan p. 67, No. 2.9	QC
4.1.18	The DMAC shall provide for the generic treatment of data sources isolating the requesting client from specific representations, unique request semantics, and protocols.	DMAC	15. DMAC Plan p. 69, No. 6.1.7	Search, Catalog & Metadata
4.1.19	The data transport service shall provide for online acquisition of data into legacy applications and new applications packages through the syntactic data model.	DMAC	15. DMAC Plan p. 77, No. 4.3	Data Transport
4.1.20	The data transport service shall be capable of binding these metadata to a data request.	DMAC	15. DMAC Plan p. 77, No. 2.10	Data Transport
4.1.21	The selection interface shall enable the user to select from the items returned from the search and to perform subsequent subsetting searches of the returned items.	DMAC	15. DMAC Plan p. 74, No. 4.9.5	Search

Table 7.1.6.1-1. System Design.

Identifier	Description	Subsystem	Reference	ICE Allocation/Notes
4.1.22	Data sets that are stored offline shall be kept accessible and discoverable through the data discovery interfaces. This access to offline data may be initiated by online ordering. Online ordering is a mechanism by which data are ordered and then picked up or delivered later.	DMAC	15. DMAC Plan p. 87, No. 7.6, 7.6.1	Data Transport
4.1.23	The DMAC system shall use the data assembly centers to gather distributed data and process data over a wide range of disciplines, with the assembled data and products then being submitted to archive centers for long-term storage and access.	DMAC	15. DMAC Plan p. 82, No. 2.8.5	Data Discovery, Archive
4.1.24	The DMAC shall leverage existing communications capabilities or provide dedicated broadband networks between/among the regional data centers, data assembly centers, modeling centers, and archive centers.	DMAC	15. DMAC Plan p. 68, No. 4.2.1	Accepted but does not need to be allocated.
4.1.25	The DMAC shall leverage existing or deploy dedicated IOOS data servers at to-be-determined locations, including up to all of the following: regional data centers, data assembly centers, modeling centers, and archive centers.	DMAC	15. DMAC Plan p. 68, No. 4.1.1	Accepted but does not need to be allocated.
4.1.26	More than one type of center shall be physically collocated; for example, a data assembly center may be an entity at a national archive center.	DMAC	15. DMAC Plan p. 80, No. 2.4	Accepted but does not need to be allocated.
4.1.27	The DMAC shall leverage existing storage or provide aggregate storage to the following: regional data centers, online (to be determine), near-line (e.g., online tape silo) (to be determined), offline (to be determined), data assembly centers, modeling centers, and archive centers	DMAC	15. DMAC Plan p. 68, No. 4.1.2	Accepted but does not need to be allocated.
4.1.28	The Observing Subsystem shall contain the necessary infrastructure to satisfy the full spectrum of current and future data telemetry bandwidth requirements.	Observing Subsystem	6. IOOS Development Plan, p. 54	Network ports, Internet connectivity and allocated bandwidth are assumed to be provided by the co-lo hosting facility.
4.1.29	The data transport service shall include an access method that is consistent with that referred to as “web services” in the literature. Other web services requirements are to be determined.	DMAC	15. DMAC Plan p. 75, No. 1.2, 1.3	Data Transport
4.1.30	The portal shall provide mechanisms for accessing web services-enabled functions of the IOOS.	DMAC	15. DMAC Plan p. 74, No. 5.5	Portal Services
4.1.31	The user feedback mechanism shall provide a mechanism for usage tracking.	DMAC	15. DMAC Plan p. 74, No. 5.17.3	CRM
Security				
4.1.32	The IOOS shall comply with Federal Information Security Management Act (FISMA) of 2002.	All	30. FISMA standards	Accepted but does not need to be allocated.
4.1.33	The IOOS shall comply with NIST SP 800-18, Guide for Developing Security Plans for Information Technology Systems.	All	31. NIST standards– SP 800-18	Accepted but does not need to be allocated.
4.1.34	The IOOS shall comply with NIST SP 800-37, Guide for Security Certification and Accreditation of Federal Information Systems.	All	32. NIST standards– SP 800-37	Accepted but does not need to be allocated.

Table 7.1.6.1-1. System Design.

Identifier	Description	Subsystem	Reference	ICE Allocation/Notes
4.1.35	The IOOS shall comply with NIST SP 800-53, Rev. 1, Recommended Security Controls for Federal Information Systems.	All	33. NIST standards– SP 800-53	Accepted but does not need to be allocated.
4.1.36	The IOOS shall comply with NIST SP 800-60, Vol. 1 and 2, Guide for Mapping Types of Information and Information Systems to Security Categories.	All	34. NIST standards– SP 800-60	Accepted but does not need to be allocated.
4.1.37	The IOOS shall comply with Federal Information Processing Standards Publications (FIPS Pubs)	All	35. FIPS Pubs	Accepted but does not need to be allocated.
4.1.38	The IOOS shall comply with FIPS PUB 199, Standards for Security Categorization of Federal Information and Information Systems.	All	36. FIPS PUB 199	Accepted but does not need to be allocated.
4.1.39	The IOOS shall comply with FIPS PUB 201, *Personal Identity Verification for Federal Employees and Contractors*, February 2005.	All	37. FIPS PUB 201	Accepted but does not need to be allocated.
4.1.40	The data transport service shall support access-restricted, secure transmission of data.	DMAC	15. DMAC Plan p.79, No. 4.9	Data Transport
4.1.41	The DMAC shall provide oversight mechanisms to ensure the proper functioning and smooth evolution of IOOS, including security.	DMAC	15. DMAC Plan p. 67, No. 2.9	Accepted but does not need to be allocated.

Table 7.1.6.2 1. Data Collection.

Identifier	Description	Subsystem	Reference	ICE Allocation / Notes
Data Quality Control				
4.2.1	The DMAC shall provide a mechanism for ensuring that data are of known and documented quality. Quality control operations are a partnership among data observation/collection components, processors, analysts, other users, and the DMAC.	DMAC	15. DMAC Plan p. 66, No. 2.2	Data Discovery, Data Transport, QC
4.2.2	Regional data centers shall apply quality control measures to data and derive specialized products.	DMAC	15. DMAC Plan p. 81, No. 2.6.3	Not an IOOS DMAC Requirement
Data Management				
4.2.3	The data archive system shall detect and correct failures in input data streams.	All IOOS subsystems	15. DMAC Plan p. 40, Data Archive and Access section	QC, Archive
4.2.4	The DMAC shall directly or indirectly facilitate activities to rescue, digitize, and provide access to legacy or historical data sets and data in danger of loss due to deteriorating media, out-of-date software, etc.	DMAC	15. DMAC Plan p. 67, No. 2.6	Assumption: This is a separately and additionally funded task that would be outsourced to a specialized contractor.
4.2.5	DMAC shall require that all data be delivered in a consistent geospatial data model.	DMAC	15. DMAC Plan Top of p. 38	Catalog & Metadata
4.2.6	The DMAC shall provide users access to real-time, delayed mode data and data collected at appropriate time scales that addresses the seven IOOS goals. The system shall provide date/time stamp information for data.	DMAC	15. DMAC Plan p. 213	Portal Services, Search
4.2.6.1	The data transport service shall support access to real-time data as well as access to retrospective (non-real-time) data.	DMAC	15. DMAC Plan p. 77, No. 4.2	Data Transport
4.2.6.2	The AA service shall receive delayed-mode data that arrives later than real-time-mode data, and sometimes much later and has a higher standard of quality control than real-time data	DMAC	15. DMAC Plan p. 213	Archive
Data Access				
4.2.7	The DMAC shall provide access to the core and ancillary variables.	DMAC	15. DMAC Plan p. 86, No. 7.3	Search, Catalog & Metadata
4.2.8	Regional data centers shall acquire and provide access to IOOS data collected in a specific geographic region.	DMAC	15. DMAC Plan p. 81, No. 2.6.1	Data Discovery
4.2.9	The system shall allow human enabled access through a DMAC-enabled browser or directly through a machine. In either case, data transport service shall provide the requisite software capability.	DMAC	15. DMAC Plan p. 77, No. 4.1.1	Portal Services, Web Services, Search
4.2.10	The DMAC shall use data assembly centers to obtain IOOS data and provide access to it.	DMAC	15. DMAC Plan p. 81, No. 2.8.1	Data Discovery, Data Transport
4.2.11	The DMAC shall allow users to rapidly exploit multiple data sets from many diverse data sources.	DMAC	15. DMAC Plan p. 259, No. 4	Search

Table 7.1.6.3-1. Metadata Management.

Identifier	Description	System/ Subsystem	Reference	ICE Allocation / Notes
4.3.1	The data discovery system shall identify a means to create and deliver metadata and data.	IOOS	15. DMAC Plan p. 71, No. 1.2, p. 72, No. 2.3	Data Discovery
4.3.2	The data discovery system shall provide the capability to provide “on-the-fly” data sets.	IOOS	15. DMAC Plan p. 73, No. 4.2, 4.7	Data Discovery
4.3.2.1	The DMAC shall provide support for users to locate and use data through the definition and maintenance of metadata (data about data).	DMAC	15. DMAC Plan p. 32, first paragraph	Search, Catalog & Metadata
4.3.3	The metadata management system (MMS) shall include mechanisms to facilitate the generation of metadata as close as possible to the collection or generation of the source data.	DMAC/MMS	15. DMAC Plan p. 72, No. 2.8	Catalog & Metadata
4.3.4	The MMS shall provide automated tools for versioning and configuration management of metadata.	DMAC/MMS	15. DMAC Plan p. 72, No. 2.9	Catalog & Metadata, Management & Business Rules
4.3.5	Documentation metadata (bibliographic information about documentation associated with a data set) shall be used for data versioning, data lineage tracking, and information citations.	DMAC	15. DMAC Plan p. 71, No. 1.5	Catalog & Metadata
4.3.6	The DMAC shall ensure that changes made to data sets are reflected in corresponding changes to the metadata records.	IOOS	15. DMAC Plan p. 33	Catalog & Metadata, Data Discovery
4.3.7	The MMS shall provide a mechanism to ensure that metadata found during data discovery are up to date, consistent, and understandable.	DMAC/MMS	15. DMAC Plan p. 71, No. 1.3	Catalog & Metadata, Data Discovery
4.3.8	A core DMAC function shall be metadata management.	DMAC	15. DMAC Plan p. 72, No 2	Catalog & Metadata
4.3.8.1	The MMS shall provide support for parent/child metadata.	DMAC/MMS	15. DMAC Plan p. 72, No. 2.5	Catalog & Metadata
4.3.8.2	Data set metadata shall be obtainable in multiple formats, including both machine-readable XML and human-readable text.	DMAC	15. DMAC Plan p. 74, No. 4.10	Catalog & Metadata
4.3.9	Data transport (DT) shall be able to transmit all relevant semantic metadata, that is translational use, descriptive use, and search metadata. They must be available in both human readable and machine readable forms.	DMAC	15. DMAC Plan p. 75	Data Transport
4.3.9.1	The DT function shall support machine-to machine interoperability with semantic meaning, i.e., the DT service shall incorporate some collection of methods that promote the scripted exchange of data between computers, with all computers involved in a transaction capable of determining both the syntax and the semantics of the exchanged data without human intervention.	DMAC	15. DMAC Plan p. 75, No. 1.1	Data Transport
4.3.9.2	The DT service shall provide the metadata needed to transform the data to a consistent semantic form, or it must be capable of delivering the data in a consistent semantic form.	DMAC	15. DMAC Plan p. 76, No. 2.8	Data Transport

Table 7.1.6.3-1. Metadata Management.

Identifier	Description	System/ Subsystem	Reference	ICE Allocation / Notes
4.3.10	The DMAC shall provide training and electronic tools to increase end users' and data providers' capacity in metadata generation and management.	DMAC	15. DMAC Plan p. 67, No. 2.5	CRM
4.3.11	The metadata shall provide a framework for both semantic and syntactic metadata.	DMAC/MMS	15. DMAC Plan p. 71, No. 1.6	Catalog & Metadata
4.3.12	When multiple data sets are aggregated, the data transport service shall provide a mechanism for providing appropriate aggregate metadata.	DMAC	15. DMAC Plan p. 77, No. 4.5.3	Data Transport
4.3.13	The MMS shall provide mechanisms for extensibility of the metadata.	DMAC	15. DMAC Plan p. 71, No. 1.4	Catalog & Metadata
4.3.14	The MMS shall provide the capability for data providers to manage their metadata within a local system or through a centralized system via remote-access capabilities.	DMAC/MMS	15. DMAC Plan p. 72, No. 2.2	Catalog & Metadata, Portal Services
4.3.15	The MMS shall include an automated metadata maintenance capability for checking URL links and any additional information within the metadata record that can be automated.	DMAC/MMS	15. DMAC Plan p. 71, No. 2.7	Catalog & Metadata
4.3.16	The MMS shall provide a mechanism to access existing metadata servers to promote harvesting metadata.	DMAC/MMS	15. DMAC Plan p. 72, No. 2.10	Catalog & Metadata
4.3.17	The MMS shall include a metadata catalog that consists of a collective holding of metadata in a distributed catalog.	DMAC/MMS	15. DMAC Plan p. 72, No. 3.1	Catalog & Metadata
4.3.17.1	The MMS metadata catalog shall provide for integration of all distributed subcatalogs.	DMAC/MMS	15. DMAC Plan p. 72, No. 3.1	Catalog & Metadata
4.3.17.2	The MMS catalog shall provide a capability to generate metadata records from self-describing data sources in which metadata and data have been integrated.	DMAC/MMS	15. DMAC Plan p. 72, No. 3.2	Catalog & Metadata
4.3.17.3	The metadata catalog shall include a stable, documented, defined application program interface (API) and a defined access protocol.	DMAC	15. DMAC Plan p. 73, No. 4.5	Catalog & Metadata, Web Services
4.3.17.4	The MMS shall be implemented as a distributed system that connects to all DMAC-compliant metadata holdings within the ocean community.	DMAC	15. DMAC Plan p. 72, No. 2.1	Catalog & Metadata, Web Services
4.3.17.5	The metadata catalog contents shall include items that will be used for discovery.	DMAC	15. DMAC Plan p. 72, No. 3.3	Catalog & Metadata, Data Discovery
4.3.17.6	The metadata catalog shall provide access control of metadata records, administrative rights and for searching on those records.	DMAC	15. DMAC Plan p. 72, No. 3.3.1	Catalog & Metadata
4.3.17.7	The metadata catalog shall allow a catalog search from public search engines.	DMAC	15. DMAC Plan p. 72, No. 3.3.2	Catalog & Metadata, Search
4.3.18	The MMS shall include mechanisms to generate, validate, maintain and approve metadata.	DMAC/MMS	15. DMAC Plan p. 72, No. 2.3, 2.6	Catalog & Metadata, Portal Services
4.3.19	The MMS shall include a set of controlled vocabularies for items such as keywords, entities and attributes, units, and other items to be determined.	DMAC/MMS	15. DMAC Plan p. 72, No. 2.4	Catalog & Metadata

Table 7.1.6.3-1. Metadata Management.

Identifier	Description	System/ Subsystem	Reference	ICE Allocation / Notes
4.3.20	The MMS shall support a linkage between data discovery and data access that an application may utilize transparently to access both remote and local data via the DMAC data transport function.	DMAC	15. DMAC Plan p. 72, No. 2.2.2	Search, Catalog & Metadata, Data Transport
4.3.21	The IOOS metadata shall be supplied using the guidelines established by the Federal Geographic Data Committee (FGDC) augmented by any applicable supplemental profiles.	DMAC	15. DMAC Plan p. 71, No. 1.1	Catalog & Metadata
4.3.22	The IOOS will include an MMS.	DMAC/MMS	15. DMAC Plan p. 72, No. 2	Catalog & Metadata
4.3.23	IOOS standards for metadata shall allow different versions of the same data and metadata to be traced by means of information on lineage and version.	IOOS	15. DMAC Plan p. 83, No. 5.4	Catalog & Metadata
4.3.24	The MMS shall support multiple standards that exist today and be extensible to include expected future metadata standards. Existing standards shall include FGDC, biological profile, shoreline profile and possible future standards.	DMAC	11.DMAC Plan p. 71-72, No. 1.8, 1.8.1, 1.8.2	Catalog & Metadata, Data Discovery, Data Transport

Table 7.1.6.4. Data Archive.

Identifier	Description	System/ Subsystem	Reference	ICE Allocation / Notes
Data Archive				
4.4.1	Archive centers shall be able to create and manage one or more copies of all IOOS data and metadata, both online and offline, according to the specified IOOS data category and according to NARA (U.S. National Archives and Records Administration) and other federal guidelines.	DMAC	15. DMAC Plan p. 84, No. 6.2	Catalog & Metadata
4.4.1.1	The DMAC shall provide for the long-term archive and stewardship of IOOS data sets and shall conform to national archive standards, as well as IOOS standards and user requirements	DMAC	15. DMAC Plan p. 67, No. 2.7	Archive
4.4.1.2	To qualify as an archive center, a data center shall be able to create and manage multiple copies of the data and metadata.	DMAC	15. DMAC Plan p. 84, No. 6.1.2, 6.1.2.1	Archive, Catalog & Metadata
4.4.1.3	Although IOOS data may flow into the archive centers over several pathways, at least one copy of each set shall reside in a designated archive center.	DMAC	15. DMAC Plan p. 211	Archive
4.4.1.4	Multiple copies of some categories of data shall be stored securely at separate locations under independent data management.	DMAC	15. DMAC Plan p. 82, No. 3.2	Archive, Catalog & Metadata
4.4.1.5	The DMAC system shall provide archive centers with a capability for the archival of metadata.	DMAC	15. DMAC Plan p. 81, No. 2.5.4	Archive
4.4.1.6	When data must be duplicated, a primary and secondary data steward shall be designated in the system.	DMAC	15. DMAC Plan p. 82, No. 3.3	Archive, Business and Management Rules
4.4.1.7	The primary data steward shall typically be an archive center and shall provide the highest level of access.	DMAC	15. DMAC Plan p. 82, No. 3.4	Archive, Business and Management Rules
4.4.1.8	The secondary steward need not maintain full access, but shall maintain the data at the same level of integrity.	DMAC	15. DMAC Plan p. 82, No. 3.5	Archive, Business and Management Rules
4.4.1.9	The archive system shall use coordinated methods for data collection, quality control, archiving, and user access. Although data may flow from observing systems to any of the four types of centers, at least one copy of each observation desired by IOOS must ultimately reside in an IOOS archive center.	DMAC	15. DMAC Plan p. 80, No. 2.1, 2.3	Archive
4.4.2	The DMAC shall allow data repositories to maintain current formats of their holdings.	DMAC	15. DMAC Plan p. 69, No. 6.1.4	Archive
4.4.3	Archive centers shall implement mechanisms to ensure integrity and completeness of the archives.	DMAC	15. DMAC Plan p. 80, No. 2.5.2	QC, Archive

Table 7.1.6.4. Data Archive.

Identifier	Description	System/ Subsystem	Reference	ICE Allocation / Notes
4.4.4.1	The archiving and access service shall guard against unrecoverable data loss by making data integrity (or security) a primary objective. Byte counts and checksums shall be calculated and used to verify that the data are uncorrupted when transmitted between data centers. These quantities shall again be calculated after every internal process at the archive centers, and then recalculated periodically on all archived data to protect against such problems as hard disk failures, media degeneration, incomplete file transfers, and malicious hacking.	DMAC	15. DMAC Plan p. 83, No. 5.2.4, 5.2.4.1, 5.2.4.1.1	QC, Archive
4.4.4.2	The archive system shall implement mechanisms to ensure that all irreplaceable data are sent and that an exact copy is received.	DMAC	15. DMAC Plan p. 83, No. 5.2.1	QC, Archive
4.4.5	IOOS DT methods, metadata standards, and data discovery interfaces shall be implemented in the archive system.	DMAC	15. DMAC Plan p. 79, No. 1.2	Archive
4.4.6	The data archive system shall receive and provide access to real-time data and metadata.	IOOS	11. IOOS Design & Implementation p. 13	Archive
4.4.7	The data archive system shall receive and provide access to delayed-mode data and metadata.	IOOS	11. IOOS Design & Implementation p. 13	Data Discovery, Catalog & Metadata, Archive
4.4.8	The data archive system shall distinguish between the original and upgraded or changed data sets via the standard metadata.	IOOS	15. DMAC Plan Top of p. 43	Data Discovery, Catalog & Metadata, Archive
4.4.9	The archiving and access service shall accommodate data access from any suitable component of the IOOS archive system.	DMAC	15. DMAC Plan p. 86, No. 7.1	Archive
4.4.91	The archiving and access service shall implement the protocol for transporting data defined in the data transport requirements.	DMAC	15. DMAC Plan p. 86, No. 7.2	Archive
4.4.9.2	The data archive system shall provide uniform access and data discovery for both humans and machines.	IOOS	15. DMAC Plan p. 79, No. 1.2	Archive, Search, Web Services
Data Maintenance				
4.4.10	The system shall maintain irreplaceable data.	DMAC	15. DMAC Plan p. 84, No. 6.3.1	Archive, Management & Business Rules
4.4.11	The archiving and access service shall maintain one copy (residence time in the archive will vary with replacement cycle) and perishable data. The archiving and access service shall maintain one copy until higher quality data are available. When decision-critical data products are derived from data in this class, and it is necessary to reproduce the data product, the perishable data may inherit an extended term for data preservation that is not obvious for the original data alone.	DMAC	15. DMAC Plan p. 85, No. 6.3.2.1, 6.3.3, 6.3.3.1, 6.3.3.2	Archive
4.4.12	The system shall maintain virtual data. No copies of the data are necessary, but an archive center and the virtual data provider should maintain separate copies of generation software and documentation.	DMAC	15. DMAC Plan p. 86, No. 6.3.4, 6.3.4.1	Requirement Unclear & Compound Requirement

7.1.6.5-1. Data Services.

Identifier	Description	System/ Subsystem	Reference	ICE Allocation / Notes
Transport and Delivery of Data				
4.5.1	The DT service shall be capable of delivering data of a given data type in a structurally consistent form across all data sets in the system.	DMAC	15. DMAC Plan p. 157	Data Transport
4.5.1.1	The DT service shall be designed and developed to accommodate heterogeneous data types and storage formats.	DMAC	15. DMAC Plan p. 160	Data Transport
4.5.2	Data providers shall use only established, fully documented formats, which the data transport methods handle.	DMAC	15. DMAC Plan p. 214	Catalog & Metadata
4.5.3	The IOOS data transport system shall provide sufficient mechanisms to ensure accurate transfers of data over the networks.	DMAC	15. DMAC Plan p. 83, No. 5.2.1	Data Transport, QC
4.5.4	The DT service shall provide a push data delivery service.	DMAC	15. DMAC Plan p. 77, No. 4.2.1	Data Transport, Web Services
4.5.5	The DT service shall support "informed pull" of data.	DMAC	15. DMAC Plan p. 77, No. 4.2.2	Data Transport, Web Services
4.5.6	The DT service shall be capable of accessing data in a variety of formats.	DMAC	15. DMAC Plan p. 156 and p. 76, No. 2.6	Data Transport, Catalog & Metadata
4.5.7	The DT service shall be capable of providing direct access to data via a variety of client programs, communicating directly with the program without the need to create data files.	DMAC	15. DMAC Plan p. 77, No. 4.1	Data Transport, Web Services
4.5.8	The DT service shall allow users to obtain data subsets as formatted files (formats to be determined) and human readable ASCII numeric values via a standard Internet browser.	DMAC	15. DMAC Plan p. 78, No. 4.3.1	Data Transport
4.5.9	The DT service shall provide access to metadata in a variety of forms, including the standard FGDC forms of the metadata, to take advantage of the metadata developed by different communities.	DMAC	15. DMAC Plan p. 76, No. 2.9	Data Transport
Data Discovery and Searches				
4.5.10	The search system shall support to-be-determined types of actual data searches along with metadata searches.	DMAC	15. DMAC Plan p. 73, No. 4.6	Search
4.5.11	The search system shall provide full text and fielded searches, including controlled vocabulary and free-text searches, including the following: single or multiple word searches, Boolean operators on multiple words, and thesauri to support text searches.	DMAC	15. DMAC Plan p. 73, No. 4.7, 4.7.1, 4.7.1.1, 4.7.1.2, 4.7.1.2.1, 4.7.1.2.2, 4.7.1.2.3	Search
4.5.12	The search system shall provide geospatial search.	DMAC	15. DMAC Plan p. 73, No. 4.7.2	Search
4.5.13	The search system shall provide temporal search.	DMAC	15. DMAC Plan p. 73, No. 4.7.3	Search

7.1.6.5-1. Data Services.

Identifier	Description	System/ Subsystem	Reference	ICE Allocation / Notes
4.5.14	The search system shall provide thematic search.	DMAC	15. DMAC Plan p. 73, No. 4.7.4	Search
4.5.15	The search system shall provide parameter search.	DMAC	15. DMAC Plan p. 73, No. 4.7.5	Search
4.5.16	The search system shall provide taxonomic information.	DMAC	15. DMAC Plan p. 73, No. 4.7.6	Search
4.5.17	The search system shall provide browsing by thematic areas.	DMAC	15. DMAC Plan p. 73, No. 4.7.7	Search
4.5.18	The search system shall provide iterative and refinement searches.	DMAC	15. DMAC Plan p. 73, No. 4.7.8	Search
4.5.19	The selection interface shall provide a graphical means of viewing a thumbnail of each data set received from the catalog search.	DMAC	15. DMAC Plan p. 73, No. 4.9.4	Search
4.5.19.1	The DMAC data discovery function shall provide a “select” functionality, which refers to those capabilities that allow an end user or data provider to examine data sets revealed from the data search and then choose sets of interest for downloading, browsing online, or accessing via the DMAC data transport function	DMAC	15. DMAC Plan p. 73, No. 4.9	Search
4.5.20	The IOOS shall include a search/query mechanism.	IOOS and DMAC	15. DMAC Plan p. 73, No. 4.0	Search
4.5.20.1	The search interface shall search the metadata catalog for records that meet user-defined criteria.	DMAC	15. DMAC Plan p. 73, No. 4.1	Search
4.5.20.2	The search interface shall allow end users and data providers to search for specific data sets.	DMAC	15. DMAC Plan p. 73, No. 4.2	Search
4.5.20.3	The search interface shall allow end users and data providers to browse metadata about IOOS data holdings.	DMAC	15. DMAC Plan p. 73, No. 4.3	Search
4.5.20.4	The search interface shall allow automated agents search for data.	DMAC	15. DMAC Plan p. 73, No. 4.4	Search
4.5.21	The system shall be extensible to support other specific searches such as search by data quality or native format.	DMAC	15. DMAC Plan p. 73, No. 4.8	Search
4.5.22	The MMS shall provide a metadata query mechanism that supports user access through an interface to any/all metadata fields.	DMAC/MMS	15. DMAC Plan p. 71, No. 1.7	Search
4.5.23	The data transport service shall provide a mechanism for subsetting data sets for retrieval, by parameter, by area, by time window, and by other criteria to be determined.	DMAC	15. DMAC Plan p. 78, No. 4.4	Data Transport
4.5.24	When subsetting data, the data transport service shall provide appropriate metadata.	DMAC	15. DMAC Plan p. 78, No. 4.4.1	Data Transport
4.5.25	The DMAC shall provide a seamless segue from data discovery to data access.	DMAC	15. DMAC Plan p. 95	Search

7.1.6.5-1. Data Services.

Identifier	Description	System/ Subsystem	Reference	ICE Allocation / Notes
4.5.26	The user interface shall allow the user to select items for downloading. This will be referred to as the selection interface.	DMAC	15. DMAC Plan p. 73, No. 4.9.1	Search
4.5.26.1	The selection interface shall display and accept selection requests for data sets from the catalog software that meet the search criteria specified by the user in the search interface.	DMAC	15. DMAC Plan p. 73, No. 4.9.2	Search
Data Availability				
4.5.27	The DMAC shall provide a means for determining what data are available within the IOOS based on queries issued by users and by other systems.	DMAC	15. DMAC Plan p. 86	Search
4.5.28	The archiving and access service shall receive real-time mode data arriving in real-time or near real-time, with the goal of being made available with minimum delay.	DMAC	15. DMAC Plan p. 82, No. 5.1.1	Archive
Data Transmission				
4.5.29	The data transport service shall be able to transmit numerical data without corruption or loss of precision.	DMAC/DT	15. DMAC Plan p. 75, No. 2.4	Data Transport, QC
Data Aggregation				
4.5.30	The data transport service shall provide mechanisms for aggregating data, including data of the same type and from same provider and data from different sources that do not or cannot share a single parent metadata record (e.g., observational data from different sources and systems). The system shall provide the capability of delivering structurally consistent data to clients. In this context, structure means the way that the data are organized, for example, grid or array.	DMAC	15. DMAC Plan p. 78, No. 4.5, 4.5.1, 4.5.2, p. 77, No. 3.3	Data Transport
Data Translation				
4.5.31	The data transport service shall be capable of moving data from a site in which they may be stored in one format to a client application that may require them in another format. Transport between sites will be implemented via an intermediate format, referred to as the data transport syntactic data model, and the data model shall be discipline neutral.	DMAC	15. DMAC Plan p. 77, No. 3.2, 3.2.1	Data Transport
4.5.31.1	The DMAC system shall provide electronic tools and techniques to perform translation among controlled vocabularies.	DMAC	15. DMAC Plan p. 131	Data Transport, Catalog & Metadata

Table 7.1.6.6-1. Standards and Interoperability.

Identifier	Description	System/ Subsystem	Reference	ICE Allocation / Notes
Standards				
4.6.1	IOOS data (data of opportunity) shall comply with IOOS standards (including metadata and quality standards).	IOOS	6. IOOS Development Plan	All
4.6.2	File-compression techniques used for transferring IOOS data shall use standard protocols with open documentation.	DMAC	15. DMAC Plan p. 84, No. 5.6	Data Transport
4.6.3	Federal Agencies and RAs shall adopt national standards and protocols for collecting observations, data telemetry, data communications, and data management.	Observing S/S	6. IOOS Development Plan p.11, No. 3.3.3 (1)	Not an IOOS DMAC Requirement
4.6.4	Operational programs of the Observing Subsystem shall provide data quality controlled and managed in compliance with Ocean.US DMAC standards and protocols.	Observing S/S	6. IOOS Development Plan, p. 9	Not an IOOS DMAC Requirement
Data Integration and Linkage				
4.6.5	The IOOS shall provide electronic tools for remote content management of the portal structure.	DMAC	15. DMAC Plan p.74, No. 5.10	Portal Services

Table 7.1.6.7-1. Portal Services.

Identifier	Description	System/ Subsystem	Reference	ICE Allocation / Notes
4.7.1	DMAC shall provide a portal through which end users can search using the Internet for IOOS data and metadata. A portal is an Internet presence (e.g., website) that redirects the user (possibly transparently) to a larger set of access points.	DMAC	15. DMAC Plan p. 74, No. 5.1	Portal Services
4.7.1.1	Simplified versions of the portal shall be available for incorporation into non-IOOS websites to provide the capability to search IOOS data.	DMAC	15. DMAC Plan p. 74, No. 5.4	Portal Services, Web Services
4.7.1.2	The IOOS portal shall consist of an entry point (a web home page), hierarchically lower level entries (other pages), and links to areas or functions within the IOOS.	DMAC & IOOS	15. DMAC Plan p. 74, No. 5.3	Portal Services
4.7.3	The portal shall provide necessary policy statements and legal disclaimers.	DMAC	15. DMAC Plan p. 74, No. 5.8	Portal Services
	The portal shall provide links to relevant information such as tools available for generation of the metadata required for this specific system.	DMAC	15. DMAC Plan p. 74, No. 5.11	Portal Services
4.7.4	The portal shall provide information on requirements for IOOS data providers.	DMAC	15. DMAC Plan p. 74, No. 5.12	Portal Services
4.7.5	The portal shall provide links to the supporting organizations.	DMAC	15. DMAC Plan p. 74, No. 5.13	Portal Services
4.7.6	The portal shall provide FAQs.	DMAC	15. DMAC Plan p. 74, No. 5.15	Portal Services
4.7.7	The portal shall provide online documentation.	DMAC	15. DMAC Plan p. 74, No. 5.16	Portal Services
4.7.8	The DMAC system shall provide basic web browsing and visualization capabilities across the breadth of IOOS data.	DMAC	15. DMAC Plan p. 59, No. (2)	Portal Services, Search

Table 7.1.6.7-8. Observing and Sensor/Data Acquisition Services.

Identifier	Description	Subsystem	Reference	ICE Allocation / Notes
4.8.1	The Observing Subsystem shall include data from the following sources:	Observing S/S	6. IOOS Development Plan, p. 25	Not an IOOS DMAC Requirement
4.8.1.1	NOAA Coastal Marine Automated Network (CMAN) programs for the coastal component.	Observing S/S	6. IOOS Development Plan, p. 25	Not an IOOS DMAC Requirement
4.8.1.2	NOAA National Data Buoy Center (NDBC) programs for the coastal component.	Observing S/S	6. IOOS Development Plan, p. 25	Not an IOOS DMAC Requirement
4.8.1.3	NOAA Physical Oceanographic Real-Time System (PORTS) programs for the coastal component.	Observing S/S	6. IOOS Development Plan, p. 25	Not an IOOS DMAC Requirement
4.8.1.4	NOAA National Estuarine Research Reserve System (NERRS) programs for the coastal component.	Observing S/S	6. IOOS Development Plan, p. 25	Not an IOOS DMAC Requirement
4.8.1.5	NOAA CoastWatch programs for the coastal component.	Observing S/S	6. IOOS Development Plan, p. 25	Not an IOOS DMAC Requirement
4.8.1.6	NOAA Living Marine Resources-Ecosystems Survey (LMRES) programs for the coastal component.	Observing S/S	6. IOOS Development Plan, p. 25	Not an IOOS DMAC Requirement
4.8.1.7	NOAA National Current Observation programs for the coastal component.	Observing S/S	6. IOOS Development Plan, p. 25	Not an IOOS DMAC Requirement
4.8.1.8	NOAA habitat assessment programs for the coastal component.	Observing S/S	6. IOOS Development Plan, p. 25	Not an IOOS DMAC Requirement
4.8.1.9	NOAA hydrographic survey programs for the coastal component.	Observing S/S	6. IOOS Development Plan, p. 25	Not an IOOS DMAC Requirement
4.8.1.10	NOAA coral reef mapping programs for the coastal component.	Observing S/S	6. IOOS Development Plan, p. 25	Not an IOOS DMAC Requirement
4.8.1.11	NOAA coral reef monitoring programs for the coastal component.	Observing S/S	6. IOOS Development Plan, p. 25	Not an IOOS DMAC Requirement
4.8.1.12	NOAA coastal mapping programs for the coastal component.	Observing S/S	6. IOOS Development Plan, p. 25	Not an IOOS DMAC Requirement
4.8.1.13	NOAA topographic change mapping programs for the coastal component.	Observing S/S	6. IOOS Development Plan, p. 25	Not an IOOS DMAC Requirement
4.8.1.14	NOAA benthic habitat mapping programs for the coastal component.	Observing S/S	6. IOOS Development Plan, p. 25	Not an IOOS DMAC Requirement
4.8.1.15	NOAA coastal change assessment mapping programs for the coastal component	Observing S/S	6. IOOS Development Plan, p. 25	Not an IOOS DMAC Requirement
4.8.1.16	NOAA ecosystem survey programs for the coastal component.	Observing S/S	6. IOOS Development Plan, p. 25	Not an IOOS DMAC Requirement
4.8.1.17	NOAA protected resources survey programs for the coastal component.	Observing S/S	6. IOOS Development Plan, p. 25	Not an IOOS DMAC Requirement
4.8.1.18	NOAA national observer program for the coastal component.	Observing S/S	6. IOOS Development Plan, p. 25	Not an IOOS DMAC Requirement

Table 7.1.6.7-8. Observing and Sensor/Data Acquisition Services.

Identifier	Description	Subsystem	Reference	ICE Allocation / Notes
4.8.1.19	NOAA recreational fisheries program for the coastal component.	Observing S/S	6. IOOS Development Plan, p. 25	Not an IOOS DMAC Requirement
4.8.1.20	NOAA commercial fisheries statistics program for the coastal component.	Observing S/S	6. IOOS Development Plan, p. 25	Not an IOOS DMAC Requirement
4.8.1.21	Navy Altimeter Data Fusions Center program for the coastal component.	Observing S/S	6. IOOS Development Plan, p. 25	Not an IOOS DMAC Requirement
4.8.1.22	U.S. Army Corps of Engineers' Coastal Field Data Collection Program for the coastal component.	Observing S/S	6. IOOS Development Plan, p. 25	Not an IOOS DMAC Requirement
4.8.1.23	U.S. Army Corps of Engineers' hydrographic surveying program for the coastal component.	Observing S/S	6. IOOS Development Plan, p. 25	Not an IOOS DMAC Requirement
4.8.1.24	USGS National Streamflow Information Program (NSIP) for the coastal component.	Observing S/S	6. IOOS Development Plan, p. 25	Not an IOOS DMAC Requirement
4.8.1.25	USGS National Stream Quality Accounting Network (NSQAN) program for the coastal component.	Observing S/S	6. IOOS Development Plan, p. 25	Not an IOOS DMAC Requirement
4.8.1.26	USGS stream-gauging programs for the coastal component.	Observing S/S	6. IOOS Development Plan, p. 25	Not an IOOS DMAC Requirement
4.8.1.27	USGS coral reef mapping and monitoring programs for the coastal component.	Observing S/S	6. IOOS Development Plan, p. 25	Not an IOOS DMAC Requirement
4.8.1.28	USGS coastal change mapping programs for the coastal component.	Observing S/S	6. IOOS Development Plan, p. 25	Not an IOOS DMAC Requirement
4.8.1.29	USGS benthic habitat mapping programs for the coastal component.	Observing S/S	6. IOOS Development Plan, p. 25	Not an IOOS DMAC Requirement
4.8.1.30	Northeast Regional Association of Coastal Ocean Observing Systems (NERACOOS) for the coastal component.	Observing S/S	13. IOOS Development Plan Addendum, p. 39, Table 13	Not an IOOS DMAC Requirement
4.8.1.31	Mid-Atlantic Coastal Ocean Observing Regional Association (MACOORA) for the coastal component.	Observing S/S	6. IOOS Development Plan, p. 5	Not an IOOS DMAC Requirement
4.8.1.32	Southeast Coastal Ocean Observing Regional Association (SECOORA) for the coastal component.	Observing S/S	6. IOOS Development Plan, p. 5	Not an IOOS DMAC Requirement
4.8.1.33	Gulf of Mexico Coastal Ocean Observing System (GCOOS) for the coastal component.	Observing S/S	6. IOOS Development Plan, p. 5	Not an IOOS DMAC Requirement
4.8.1.34	Great Lakes Observing System (GLOS) for the coastal component.	Observing S/S	6. IOOS Development Plan, p. 5	Not an IOOS DMAC Requirement
4.8.1.35	Caribbean Regional Association (CaRA) for the coastal component.	Observing S/S	6. IOOS Development Plan, p. 5	Not an IOOS DMAC Requirement
4.8.1.36	Southern California Coastal Ocean Observing System (SCCOOS) for the coastal component.	Observing S/S	6. IOOS Development Plan, p. 5	Not an IOOS DMAC Requirement
4.8.1.37	Central and Northern California Ocean Observing System (CeNCOOS) for the coastal component.	Observing S/S	6. IOOS Development Plan, p. 5	Not an IOOS DMAC Requirement

Table 7.1.6.7-8. Observing and Sensor/Data Acquisition Services.

Identifier	Description	Subsystem	Reference	ICE Allocation / Notes
4.8.1.38	Northwest Association of Networked Ocean Observing Systems (NANOOS) for the coastal component.	Observing S/S	6. IOOS Development Plan, p. 5	Not an IOOS DMAC Requirement
4.8.1.39	Alaska Ocean Observing System (AOOS) for the coastal component.	Observing S/S	6. IOOS Development Plan, p. 5	Not an IOOS DMAC Requirement
4.8.1.40	Pacific Islands Integrated Ocean Observing System (PacIOOS) for the coastal component.	Observing S/S	6. IOOS Development Plan, p. 5	Not an IOOS DMAC Requirement
4.8.1.41	NOAA Geostationary Operational Environmental Satellite (GOES) program for the global and coastal components.	Observing S/S	6. IOOS Development Plan, p. 22, 25	Not an IOOS DMAC Requirement
4.8.1.42	NOAA National Water Level Observation Network (NWLON) and tide gauge programs for the global and coastal components.	Observing S/S	6. IOOS Development Plan, p. 22, 25	Not an IOOS DMAC Requirement
4.8.1.43	Navy integrated buoy program for the global and coastal components.	Observing S/S	6. IOOS Development Plan, p. 22, 25	Not an IOOS DMAC Requirement
4.8.1.44	Ocean Biogeographic Information System for the global and coastal components.	Observing S/S	6. IOOS Development Plan, p. 23, 31	Not an IOOS DMAC Requirement
4.8.1.45	NOAA moored buoy (tropical array) programs for the global component.	Observing S/S	6. IOOS Development Plan, p. 22, 44 (3)	Not an IOOS DMAC Requirement
4.8.1.46	NOAA drifting buoy array program for the global component.	Observing S/S	6. IOOS Development Plan, p. 22, 44 (2)	Not an IOOS DMAC Requirement
4.8.1.47	NOAA voluntary observing ships program for the global component.	Observing S/S	6. IOOS Development Plan, p. 22	Not an IOOS DMAC Requirement
4.8.1.48	NOAA ships of opportunity program for the global component.	Observing S/S	6. IOOS Development Plan, p. 22, 44 (4)	Not an IOOS DMAC Requirement
4.8.1.49	NOAA dedicated ships program for the global component.	Observing S/S	6. IOOS Development Plan, p. 22, 44 (9)	Not an IOOS DMAC Requirement
4.8.1.50	NOAA Arctic sea ice flux program for the global component.	Observing S/S	6. IOOS Development Plan, p. 22, 44 (6)	Not an IOOS DMAC Requirement
4.8.1.51	Global Tide Gauge Program for the global component.	Observing S/S	6. IOOS Development Plan, p. 22, 44 (1)	Not an IOOS DMAC Requirement
4.8.1.52	GEOSAT Follow On program for the global component.	Observing S/S	6. IOOS Development Plan, p. 22	Not an IOOS DMAC Requirement
4.8.1.53	Navy ocean survey ship program for the global component.	Observing S/S	6. IOOS Development Plan, p. 22	Not an IOOS DMAC Requirement
4.8.1.54	Joint WINDSAT program for the global component.	Observing S/S	6. IOOS Development Plan, p. 22	Not an IOOS DMAC Requirement
4.8.1.55	NSF OOI program when it reaches the pre-operational phase.	Observing S/S	6. IOOS Development Plan, p. 44 (7)	Not an IOOS DMAC Requirement
4.8.1.56	Full Depth Ocean Surveys and Ocean Carbon Monitoring program once it reaches pre-operational phase.	Observing S/S	6. IOOS Development Plan, p. 44 (8)	Not an IOOS DMAC Requirement

Table 7.1.6.7-8. Observing and Sensor/Data Acquisition Services.

Identifier	Description	Subsystem	Reference	ICE Allocation / Notes
4.8.1.57	NOAA Polar Operational Environmental Satellite (POES) program for the global and coastal components.	Observing S/S	6. IOOS Development Plan, p. 22, 25	Not an IOOS DMAC Requirement
4.8.2	The Observing Subsystem shall leverage existing assets operated by federal and state agencies, universities, coastal laboratories, and other organizations.	Observing S/S	6. IOOS Development Plan, p. 19	Not an IOOS DMAC Requirement
4.8.3	The Observing Subsystem shall provide for the ability to serve data of opportunity from a variety of untraditional sources.	Observing S/S	6. IOOS Development Plan	Not an IOOS DMAC Requirement
4.8.3.1	Data of opportunity shall support IOOS core variables and apply to societal goals.	Observing S/S	6. IOOS Development Plan	Not an IOOS DMAC Requirement
4.8.4	The Observing Subsystem shall measure core variables including data and information from subsystems.	Observing S/S	6. IOOS Development Plan, p. 20	Not an IOOS DMAC Requirement
4.8.5	The Observing Subsystem shall initially consist of a set of mature pre-operational and operational observing programs.	Observing S/S	6. IOOS Development Plan, p. 22	Not an IOOS DMAC Requirement
4.8.6	The Observing Subsystem shall provide a fusion of remotely sensed and *in situ* observations.	Observing S/S	6. IOOS Development Plan, p. 21	Not an IOOS DMAC Requirement
4.8.7	The Observing Subsystem shall be developed with the flexibility to handle the expansion of in situ and remotely sensed observations in the global component.	Observing S/S	6. IOOS Development Plan, p. 43	Not an IOOS DMAC Requirement
4.8.8	The Observing Subsystem shall provide for the ability to serve data from applicable research systems as they mature to pre-operational status.	Observing S/S	6. IOOS Development Plan, Part III	Not an IOOS DMAC Requirement
4.8.8.1	Network of HF radar nodes for coastal current mapping nationwide.	Observing S/S	6. IOOS Development Plan, Part III page 63	Not an IOOS DMAC Requirement
4.8.9	EPA's National Estuary Program (NEP > http://www.epa.gov/nep/)	Observing S/S	OOS Development Plan ADDENDUM, p. 65	Not a requirement
4.8.10	EPA's National Coastal Assessment Program (NCAP http://www.epa.gov/emap/nca/):	Observing S/S	IOOS Development Plan ADDENDUM (Table II.4, pages 20, 22)	Not a requirement
4.8.11	EPA's Beach Environmental Assessment and Coastal Health (BEACH) Program	Observing S/S	IOOS Development Plan ADDENDUM (Table II.4, pages 20, 23	Not a requirement
4.8.12	EPA's (and NOAA) National Marine Debris Monitoring Programs (NMDMP)	Observing S/S	IOOS Development Plan ADDENDUM (Table II.4, p. 20	Not a requirement

Table 7.1.6.7-9. Research and Education Services.

Identifier	Description	System/ Subsystem	Reference	ICE Allocation / Notes
4.9.1	The IOOS shall provide information relevant to the education sector.	IOOS	13. First IOOS Development Plan Addendum, p. 40	Portal Services, CRM
4.9.1.1	The IOOS shall provide the education sector with guidelines and policies for citing IOOS-obtained information in publications.	IOOS	13. First IOOS Development Plan Addendum, p. 40	Portal Services, CRM
4.9.1.2	Educational materials available via IOOS shall be highlighted with the intended audience (parents, teachers, students) and expertise level (grade, undergraduate, etc.).	IOOS	13. First IOOS Development Plan Addendum, p. 42	Portal Services, CRM
4.9.2	The IOOS portal's graphical user interfaces (GUIs) shall be simple to use for a broad spectrum of users.	DMAC and IOOS	15. DMAC Plan p. 74, No. 5.2	Portal Services, Search

Table 7.1.6.10-1. Administrative Services.

Identifier	Description	System/ Subsystem	Reference	ICE Allocation / Notes
General				
4.10.1	The IOOS shall establish priorities for detecting, measuring, and predicting ocean parameters and phenomena at the national and regional levels.	IOOS	6. IOOS Development Plan, p. 4 (7)	Management & Business Rules
4.10.2	Data products shall include assimilation-friendly, real-time measurements, model nowcasts and forecasts, GIS layers, and climatological reference fields. * Products shall be defined as data products, graphical information products, or text information products (was 3.14.11).	DMAC	15. DMAC Plan p. 66, No. 2.4	Modeling & Analysis (and really the whole DMAC system)
4.10.3	Graphical information products shall include scientific plots and maps, imagery, and photographs.	DMAC	15. DMAC Plan p. 66, No. 2.4	Modeling & Analysis (and really the whole DMAC system)
4.10.4	Text information products shall include written forecasts and numerical tables.	DMAC	15. DMAC Plan p. 66, No. 2.4	Modeling & Analysis (and really the whole DMAC system)
4.10.5	Acceptable tools and procedures shall include the following.	DMAC	15. DMAC Plan p. 83, No. 5.2.2	
4.10.5.1	Receipts and reconciliation reports for transfers over networks		15. DMAC Plan p. 83, No. 5.2.2.1	Metrics
4.10.5.2	Skilled staff to review metrics (e.g., how much of the expected data were received and how much of the data set was made available)	DMAC	15. DMAC Plan p. 83, No. 5.2.2.2	Metrics
4.10.5.3	Byte counts, inventories of data files, and checksums of records or files	DMAC	15. DMAC Plan p. 83, No. 5.2.2.3	Metrics
4.10.5.4	Test files that can be confirmed against archived data and used to verify local software, accuracy relative to other data sources (i.e., whether a set of data falls within acceptable ranges or compare acceptably with other data known to be correct).	DMAC	15. DMAC Plan p. 83, No. 5.2.2.4, 5.2.2.5	QC

Table 7.1.6.11-1. NOAA requirements.

Identifier	Description	System/ Subsystem	Reference	ICE Allocation / Notes
4.11.1	The IOOS shall provide a mechanism for aggregating and buffering data streams over useful spans of time and space.	DMAC	15. DMAC Plan p. 66, No. 2.3	Search, Modeling & Analysis
4.11.2	The IOOS shall transmit timely wind observations to the models. This is to minimize data latency.	IOOS	9. Hurricane Intensity Modeling Draft Report, p. 4	Data Transport, Modeling & Analysis
4.11.3	The IOOS shall comply with NOAA data standards and ensure that data providers deliver data of a known quality.	IOOS	9. Hurricane Intensity Modeling Draft Report, p. 4	Data Discovery, Data Transport, QC
4.11.4	The IOOS shall provide a mechanism for ensuring that data are of known and documented quality.	IOOS	15. DMAC Plan p. 66, No. 2.2	QC
4.11.5	The DIF shall provide data of known quality from sources of Seven core variables that are needed by the four models/assessments/products.	DIF	8. NOAA IOOS Project Requirements Document, p. 13, No. 5.1.6	QC
4.11.6	The DIF shall provide access and delivery from the Seven core variables such that it can be incorporated into the customer-identified hurricane intensity model or process.	DIF	8. NOAA IOOS Project Requirements Document, p. 13, No. 5.2.1	Search, Modeling & Analysis
4.11.7	The IOOS shall directly or indirectly facilitate activities to rescue, digitize, and provide access to legacy or historical data sets and data in danger of loss due to deteriorating media, out-of-date software, etc.	IOOS	15. DMAC Plan p. 67, No. 2.6	Assumption: This is a separately and additionally funded task that would be outsourced to a specialized contractor.
4.11.8	The IOOS shall provide access to historical data not currently available in the archives.	IOOS	10. IEA Draft Requirements for IOOS, p. 2	Requirement Unclear
4.11.9	The IOOS shall provide access to fishery data.	IOOS	10. IEA Draft Requirements for IOOS, p. 4	Search, Modeling & Analysis
4.11.10	The IOOS shall help improve access to regional and other non-NOAA data resources (to address data gaps).	IOOS	9. Hurricane Intensity Modeling Draft Report, p. 4	Requirement Unclear
4.11.11	The IOOS shall provide streamlined access to bathymetry and topography data.	IOOS	20. Coastal Inundation Modeling, p. 5, part III A.	Search, Modeling & Analysis (assuming data exists and is accessible)
4.11.12	The archiving and access service shall provide access to data using core protocols (FTP, HTTP, OPeNDAP) along with other IOOS data transport protocols.	DMAC	15. DMAC Plan p. 86, No. 7.4	Data Discovery, Data Transport

Table 7.1.6.11-1. NOAA requirements.

Identifier	Description	System/ Subsystem	Reference	ICE Allocation / Notes
4.11.13	The DIF shall provide access and delivery of data from the Seven core variables such that it can be incorporate into the customer-identified Harmful Algal Bloom (HAB) model or process.	DIF	8. NOAA IOOS Project Requirements Document p. 13, No. 5.4.1	Search, Data Discovery, Data Transport, Modeling & Analysis
4.11.14	The DIF shall provide access and delivery of data from the Seven core variables such that it can be incorporated into the customer-identified IEA model or process.	DIF	8. NOAA IOOS Project Requirements Document p. 14, No. 5.5.1	Search, Data Discovery, Data Transport, Modeling & Analysis
4.11.15	All archive systems shall have a means of soliciting and capturing user feedback on services and data sets.	IOOS	15. DMAC Plan p. 88, No. 7.9.3.4.1	Archive, CRM (DMAC only)
4.11.16	The DMAC shall provide training and electronic tools to increase end users' and data providers' capacity in metadata generation and management.	DMAC	15. DMAC Plan p. 67, No. 2.5	Portal Services, CRM
4.11.17	The DIF shall provide metadata for data and products derived from the Seven core variables that are needed by the four models/assessments/products.	DIF	8. NOAA IOOS Project Requirements Document, p. 13, No. 5.1.7	Search, Data Discovery, Data Transport, Modeling & Analysis
4.11.18	The DMAC shall provide a means for determining what data are available within the IOOS based on queries issued by users and by other systems.	DMAC	15. DMAC Plan p. 67, No. 2.8	Search, Web Services
4.11.19	The DIF shall allow for discovery, access, and delivery (transport) of selected data sources external to NOAA for the Seven core variables that are needed by the four models/ assessments/products.	DIF	8. NOAA IOOS Project Requirements Document, p. 12, No. 5.1.3	Search, Data Discovery, Data Transport, Modeling & Analysis
4.11.20	The DIF shall allow for discovery, access, and delivery (transport) of both real time (24/7) and delayed mode data for NOAA and selected non-NOAA data sources of the Seven core variables that are needed by the four models/assessments/products.	DIF	8. NOAA IOOS Project Requirements Document, p. 13, No. 5.1.5	Search, Data Discovery, Data Transport, Modeling & Analysis
4.11.21	The IOOS shall transmit data as close to the time of collection as possible. The utility of certain data sets will degrade faster than others; however, providers should always attempt to minimize the lag time between the observation and the point at which it is delivered to the processing centers.	IOOS	9. Hurricane Intensity Modeling Draft Report, p. 5	Data Discovery, Data Transport
4.11.22	The IOOS shall transmit data as close to the time of collection as feasible to prevent certain data sets from degrading.	IOOS	20.Coastal Inundation Modeling, p. 6, letter D	Data Discovery, Data Transport
4.11.23	Data assembly shall allow users to exploit real-time data, especially data from distributed sensor arrays.	DMAC	15. DMAC Plan p. 66, No. 2.3	Data Discovery, Data Transport (if available at other DAC)
4.11.24	The IOOS shall provide the capability for the collection and transmission of data from sensor subsystems at entry points where the data become available using DMAC standards and protocols. (3.6.59 10. IOOS Data Integration Framework)	DIF	15. DMAC Plan p. 66, No. 2.1	Data Discovery, Data Transport
4.11.25	IOOS shall provide for communications of metadata among components of the system.	DMAC	15. DMAC Plan p. 67, No. 2.5	Catalog & Metadata

Table 7.1.6.11-1. NOAA requirements.

Identifier	Description	System/ Subsystem	Reference	ICE Allocation / Notes
4.11.26	The DIF shall support the testing and validation of the customer-identified hurricane intensity model or process.	DIF	8. NOAA IOOS Project Requirements Document, p. 13, No. 5.2.2	Modeling & Analysis
4.11.27	The DIF shall support the testing and validation of the coastal inundation customer-identified model or process.	DIF	8. NOAA IOOS Project Requirements Document, p. 13, No. 5.3.1	Modeling & Analysis
4.11.28	The DIF shall support the testing and validation of the HAB customer-identified model or process.	DIF	8. NOAA IOOS Project Requirements Document, p. 13, No. 5.4.2	Modeling & Analysis
4.11.29	The DIF shall support the testing and validation of the IEA customer-identified model or process.	DIF	8. NOAA IOOS Project Requirements Document, p. 14, No. 5.5.2	Modeling & Analysis
4.11.30	The DIF shall allow for subsetting of data in space and time from the Seven core variables that are needed by the four models/assessments/products.	DIF	8. NOAA IOOS Project Requirements Document, p. 12, No. 5.1.4	Search, Data Transport
4.11.31	The DIF shall provide a capability to merge or overlay disparate sources of data for each of the core variables into georegistered products that are needed by the four models/ assessments/products.	DIF	8. NOAA IOOS Project Requirements Document, p. 13, No. 5.1.6	Modeling & Analysis
4.11.32	The DIF shall allow the four models/assessments/products to be validated in an operational mode.	DIF	8. NOAA IOOS Project Requirements Document, p. 13, No. 5.1.8	Modeling & Analysis
4.11.33	The IEOS shall provide information critical to improving mitigation strategies and providing systematic and sustained monitoring of regions at risk.	IEOS	5. Strategic Plan for the IEOS, p. 81, letter B	Not an IOOS Requirement
4.11.34	The IOOS shall provide documentation to ensure utility of the data.	IOOS	9. Hurricane Intensity Modeling Draft Report, p. 4	Portal Services, CRM
4.11.35	The DIF shall implement NOAA GEO-IDE and other NOAA requirements for security and data management necessary to serve the requirements of the four models/assessments/ products.	DIF	8. NOAA IOOS Project Requirements Document, p. 12, No. 5.1.1	Accepted but not allocated
4.11.36	The IOOS shall provide documentation to ensure utility of the data.	IOOS	9. Hurricane Intensity Modeling Draft Report, p. 4	Duplicate Requirement to 4.11.34

Table 7.1.6.11-1. NOAA requirements.

Identifier	Description	System/ Subsystem	Reference	ICE Allocation / Notes
4.11.37	The IOOS shall provide oversight mechanisms to ensure the proper functioning and smooth evolution of IOOS. Those mechanisms include fault detection and correction, security, monitoring and evaluation of system performance, providing for system extensibility, establishment and publicizing of data availability policies, soliciting and responding to user feedback, and establishing and maintaining international linkages.	DMAC	15. DMAC Plan p. 67, No. 2.9	Accepted but not allocated
4.11.38	Real-time NWLON data shall be used during the event to monitor the water level and for post-verification of the model to determine how well the model is operating.	IOOS	20. Coastal Inundation Modeling, p. 3, No. III	Modeling & Analysis
4.11.39	Forecasting winds shall be used to establish forcing and boundary conditions for the models.	IOOS	20. Coastal Inundation Modeling, p. 4	Modeling & Analysis
4.11.40	Bathymetry and topography shall be used to initialize the SLOSH (Sea, Lake and Overland Surges from Hurricanes) and ADCIRC (Advanced Circulation) ADCIRC grid and configure the model.	IOOS	20. Coastal Inundation Modeling, p. 4	Modeling & Analysis
4.11.41	One of the parameters shall be used to estimate storm surge heights and compare the difference between the storm's central pressure and the surrounding undisturbed atmosphere.	IOOS	20. Coastal Inundation Modeling, p. 5	Modeling & Analysis

Table 7.1.6.12-1. GEOSS, GOOS, IEOS requirements.

Identifier	Description	System	Reference	ICE Allocation / Notes
4.12.1	The GEOSS shall make data, metadata, and products available with minimal time delay and at minimal cost.	GEOS	1. GEOSS 10 Year Implementation Plan, p. 8, No. 5.4	Not an IOOS Requirement
4.12.2	The GEOSS shall provide research and education entities with shared data, metadata, and products free of charge or at no more than the cost of reproduction.	GEOS	1. GEOSS 10 Year Implementation Plan, p. 8, No. 5.4	Not an IOOS Requirement
4.12.3	The GEOSS shall provide full and open exchange of data, metadata, and products shared within GEOSS, recognizing relevant international instruments and national policies and legislation.	GEOSS	1. GEOSS 10 Year Implementation Plan, p. 8, No. 5.4	Not an IOOS Requirement
4.12.4	GEOSS shall use existing international standards for interoperability. Those standards include objectives issued by such organizations and institutes.	GEOSS	1. GEOSS 10 Year Implementation Plan, p. 7, No. 5.3	Not an IOOS Requirement
4.12.5	GEOSS shall draw on existing Spatial Data Infrastructure components as institutional and technical precedents in areas such as geodetic reference frames, common geographic data, and standard protocols.	GEOSS	1. GEOSS 10 Year Implementation Plan, p. 7, No. 5.3	Not an IOOS Requirement
4.12.6	The GOOS shall provide a free exchange of data.	GOOS	3. User Requirements for the GOOS, p. 24	Not an IOOS Requirement
4.12.7	The GOOS Living Marine Resources module shall provide a system that monitors marine ecosystems and the biological, chemical, and physical parameters controlling their variability.	GOOS	2. Strategic Plan and Principles for the GOOS, p. 7	Not an IOOS Requirement
4.12.8	The GOOS Climate module shall monitor and describe the physical and bio-geochemical processes that determine ocean circulation and its influence on the carbon cycle as well as the effects of the ocean on seasonal to multi-decadal climatic changes.	GOOS	2. Strategic Plan and Principles for the GOOS, p. 7, No. (i)	Not an IOOS Requirement
4.12.9	GOOS shall provide international communication networks and efficient, standard formats and codes.	GOOS	3. User Requirements for the GOOS, p. 8	Not an IOOS Requirement
4.12.10	GOOS shall provide an integrated international database.	GOOS	3. User Requirements for the GOOS, p. 8	Not an IOOS Requirement
4.12.11	The GOOS Health of the Ocean (HOTO) module shall access available data on contaminant levels and community response at regional and national levels to provide baselines to underpin monitoring.	GOOS	2. Strategic Plan and Principles for the GOOS, p. 7, No. (iv)	Not an IOOS Requirement
4.12.12	The GOOS HOTO module shall develop a set of reliable, applicable biological distress indicators of the health of the environment.	GOOS	2.Strategic Plan and Principles for the GOOS, p. 7, No. (i)	Not an IOOS Requirement
4.12.13	GOOS shall provide a design that is flexible, expandable, and adaptable to changing needs, technology, and implementation constraints.	GOOS	2. Strategic Plan and Principles for the GOOS, p. 6, No. 3.1	Not an IOOS Requirement

Table 7.1.6.12-1. GEOSS, GOOS, IEOS requirements.

Identifier	Description	System	Reference	ICE Allocation / Notes
4.12.14	GOOS shall provide accurate descriptions of the present state of the oceans, including living resources.	GOOS	2. Strategic Plan and Principles for the GOOS, p. 3, 7	Not an IOOS Requirement
4.12.15	GOOS shall provide continuous forecasts of the future conditions of the sea for as far ahead as possible.	GOOS	4. GOOS Data & Information Strategy Plan	Not an IOOS Requirement
4.12.16	The GOOS Services module shall assist the other module panels with establishing services and products and ways in which the provision of existing services and products can be improved.	GOOS	2. Strategic Plan and Principles for the GOOS, p. 8	Not an IOOS Requirement
4.12.17	GOOS shall be implemented in a phased approach.	GOOS	2. Strategic Plan and Principles for the GOOS, p. 3, No. 1.6	Not an IOOS Requirement
4.12.18	The GOOS Climate module shall provide the observations needed for the prediction of climate variability and climate change.	GOOS	2. Strategic Plan and Principles for the GOOS, p. 7, No. (ii)	Not an IOOS Requirement
4.12.19	The GOOS Coastal module shall take into account and integrate the plans and recommendations of the climate, HOTO, and LMR panels.	GOOS	2. Strategic Plan and Principles for the GOOS, p. 7	Not an IOOS Requirement
4.12.20	GOOS shall provide the basis for forecasts of climate change.	GOOS	4. GOOS Data & Information Strategy Plan, p. 9, No. 2.4	Not an IOOS Requirement
4.12.21	The GOOS Coastal module shall take into account the needs of a wider range of users, for instance, the communities involved in coastal management, environmental protection, ports, and shipping. Monitoring, documenting, and forecasting change in this environment will require integration of physical, chemical, biological, and geological observations and consideration of socio-economic requirements.	GOOS	2. Strategic Plan and Principles for the GOOS, p. 7	Not an IOOS Requirement
4.12.22	The IEOS data shall be available for the operational, research, commercial, and academic communities with minimal time delay and at minimal cost.	IEOS	5. Strategic Plan for the IEOS, p. 35, letter A	Not an IOOS Requirement
4.12.23	The IEOS shall provide full and open access to data in accordance with OMB Circular A-130.	IEOS	5. Strategic Plan for the IEOS, p. 35, letter A	Not an IOOS Requirement
4.12.24	The IEOS shall facilitate the sharing and applied usage of global, regional, and local data.	IEOS	5. Strategic Plan for the IEOS	Not an IOOS Requirement
4.12.25	The IEOS shall facilitate the sharing and applied usage of data from satellites, ocean buoys, weather stations and other surface and airborne earth observing instruments and predictive models.	IEOS	5. Strategic Plan for the IEOS, Letter from John Marburger, III	Not an IOOS Requirement
4.12.26	The IEOS shall provide a monitoring system that supports risk assessment surveys.	IEOS	5. Strategic Plan for the IEOS, p. 81, letter B	Not an IOOS Requirement

Table 7.1.6.12-1. GEOSS, GOOS, IEOS requirements.

Identifier	Description	System	Reference	ICE Allocation / Notes
4.12.27	The IEOS shall conform to regulations and policies, including OMB Circular A-16, Federal Enterprise Architecture (FEA), Data Quality Act, and OMB's information quality guidelines.	IEOS	5. Strategic Plan for the IEOSS	Not an IOOS Requirement
4.12.28	The IEOS shall record and store observations and products in clearly defined formats, with metadata and quality indications to enable search and retrieval, and shall archive them as accessible data sets. Prioritization for detecting, measuring, and predicting ocean parameters and phenomena shall be established at the national and regional levels.	IEOS	5. Strategic Plan for the IEOS, p. 45	Not an IOOS Requirement
4.12.29	The IEOS shall integrate the wide variety of Earth observations across disciplines, institutions, and temporal and spatial scales.	IEOS	5. Strategic Plan for the IEOS, p. 59-60	Not an IOOS Requirement
4.12.30	The IEOS shall provide data management.	IEOS	5. Strategic Plan for the IEOS, p. 59-60	Not an IOOS Requirement

7.2 WBS DICTIONARY

This section presents the work breakdown structure for the IOOS that was used as a basis for partitioning development, operations, and sustainment costs. Table 7.2-1 provides the functional areas identified and merged with the CARD in order to properly account for, on a best-efforts basis, the wide variety of IOOS system functions. Differences between the IOOS WBS and the CARD definitions necessitated a re-mapping of some CARD WBS elements to conform to both the CARD requirements and the IOOS categories.

Table 7.2-1. Work Breakdown Dictionary showing definition of functional areas by WBS identifier and functional responsibility.

Appendix C WBS	CARD System Config. Supporting Paragraph Reference	Definition
1.1. Observing subsystems	1.2.1	As described in the U.S. IOOS Blueprint, the observing system subsystem will serve as the source of U.S. IOOS-provided data. U.S. IOOS accesses the data from databases such as data assembly centers (which collect ocean observation data, make metadata available, and control data quality), archives (where ocean observation data previously available from a DAC are maintained for long-term access), and sponsored models (models and other analytical tools that take raw or refined ocean observation data and provide a value added output that is of such significance to the U.S. IOOS community that the output is specifically served through U.S. IOOS). The observing subsystem is the foundation of IOOS and consists of two interdependent components: the federal and non-federal observing systems. The observing subsystem will monitor changes on global, national, and regional scales. Ocean and coastal observation data are critical for understanding ocean and atmospheric environments and are essential for predicting changes that may threaten our nation's economy, public health, and safety. Observing is executed through the following functions: Observing subsystem management; Surveys; Optimization studies; Asset management. This subsystem comprises the collection of sensor and non-sensor marine environment measurements and their transmission from regional and national platforms. Accordingly, the observing subsystem is responsible for data quality assurance/quality control (QA/QC) and for initial metadata generation for the measurements being made and transmitted. U.S. IOOS observing subsystem data collectors transmit their data from the sensor (hardware or human) to data providers such as ocean data assembly centers (DACs) and ocean data archive centers.
1.1.1. Observing subsystem management	1.2.1.1	As described in the U.S. IOOS Blueprint, this function will oversee and manage the observing functional subsystem of U.S. IOOS.

Table 7.2-1. Work Breakdown Dictionary showing definition of functional areas by WBS identifier and functional responsibility.

Appendix C WBS	CARD System Config. Supporting Paragraph Reference	Definition
1.1.1.1 Central function	1.2.1.1.1	Observing subsystem management is a requisite central function. The following decomposes this function into sub activities. Requirements definition: Gather observing system requirements, perform analysis, and recommend plans to address the requirements. (See Section 3 of the CARD for more information on requirements.) Observing systems sharing agreements: Broker agreements to share observing platforms and/or sensor outputs. Unfulfilled requirements management: Manage data/services customer and observing subsystem requirements that could not be satisfied by existing data providers (U.S. IOOS or non-U.S. IOOS), existing model outputs (U.S. IOOS and non-U.S. IOOS), or DMAC services (existing, modified, or planned).
1.1.1.2 Federal assets	1.2.1.1.2	Many observing assets are or will be provided by federal participants. Federal partners will have to participate in the formation and execution of sharing agreements for observing systems and to continue managing those observing systems. The level of effort needed for observing subsystem management will be directly tied to the federal observing assets participating in U.S. IOOS and managed by federal entities. Many federally provided observing assets are managed by RAs.
1.1.1.3 Non-federal assets	1.2.1.1.3	Many observing assets are provided or managed by RAs. The level of effort associated with observing subsystem management is described in terms of current staffing and facilities and appears in Sections 4 and 9 of the CARD.
1.1.2. Surveys	1.2.1.2	As described in the U.S. IOOS Blueprint, this function will conduct surveys of ocean observing capability and assets across the ocean observing subsystem, including U.S. IOOS partners and non-U.S. IOOS assets.
1.1.2.1 Central function	1.2.1.2.1	The U.S. IOOS Program Office is currently surveying federal and non-federal observing systems. Plans to update and conduct future surveys should also be described here, in terms of the information that will be requested and the level of effort by number of persons estimated to be involved in the effort, over a stated period of time.
1.1.2.2 Federal assets	1.2.1.2.2	Federal partners are being asked to self-identify observing assets in the existing survey. The information they provide should be described here.
1.1.2.3 Non-federal assets	1.2.1.2.3	The non-federal RAs have published web-based descriptions of their observing assets. Appendix A contains a table listing and describing information on RA assets available to support U.S. IOOS. Other efforts to survey assets will be retained with RA leadership.
1.1.3. Optimization studies	1.2.1.3	As described in the U.S. IOOS Blueprint, this function will utilize survey data and conduct optimization studies to identify actions that will improve ocean observations to meet current requirements or future plans. U.S. IOOS is charged with identifying efficiencies in ocean observation. U.S. IOOS sees to make prudent use of taxpayer funds by encouraging and forming partnerships to promote ocean observing with extant assets. U.S. IOOS will optimize its program dollars in concert with federal and non-Federal partners to avoid duplicative functions.

Table 7.2-1. Work Breakdown Dictionary showing definition of functional areas by WBS identifier and functional responsibility.

Appendix C WBS	CARD System Config. Supporting Paragraph Reference	Definition
1.1.3.1 Central function	1.2.1.3.1	The U.S. IOOS Program Office will use the survey results to derive a picture of the existing assets and data collection activities. Following that survey, the U.S. IOOS Program Office will develop optimization studies. The nature of those optimization studies, including number of people involved, the offices and interests represented, and the length of time associated with those surveys, should be described here.
1.1.3.2 Federal assets	1.2.1.3.2	The optimization studies will be done primarily by the U.S. IOOS Program Office, with assistance from the RAs. Participation from federal partners in optimization planning may occur one on one with cooperating agencies like NASA's Jet Propulsion Laboratory, EPA, and USGS, and at the budget programming level with OMB and congressional staffs.
1.1.3.3 Non-federal assets	1.2.1.3.3	The non-federal RAs are key contributors in optimization. To an extent, the RAs optimize each budget request to take account of existing capabilities and leverage new ones, while maintaining existing assets. The primary and secondary points of contact for each RA are also charged with gap analysis and optimization. While an initial gap analysis is expected to take 1 year, subsequent optimization will be an ongoing activity, as stakeholder needs change with a changing world, technological innovations enable more effective and efficient data collection and quality assurance/checking and data transmission.
1.1.4. Asset management	1.2.1.4	As described in the U.S. IOOS Blueprint, this function will manage U.S. IOOS-owned observing system assets. These processes relate to items that are part of the U.S. IOOS property book or for which U.S. IOOS bears life-cycle management responsibilities. Additionally, U.S. IOOS shares responsibility for acquiring, fielding, and managing assets owned by federal or non-federal partners. U.S. IOOS collectively manages the data and data products of U.S. IOOS assets and cooperating assets; so U.S. IOOS shares oversight of the assets in a contributory fashion. As an example, if an asset belonging to a federal partner is damaged or destroyed by natural phenomena, and that asset contributes data to U.S. IOOS, IOOS will report the outage and assist with monitoring the restoration of the asset and its data flow.
1.1.4.1 Central function	1.2.1.4.1	Asset management is a requisite central function. The following decomposes this function into sub activities. Accountability: Add and manage assets in the U.S. IOOS property book. Life-cycle management: Manage the full life cycle of assets from development and procurement through retirement.

Table 7.2-1. Work Breakdown Dictionary showing definition of functional areas by WBS identifier and functional responsibility.

Appendix C WBS	CARD System Config. Supporting Paragraph Reference	Definition
1.1.4.2 Federal assets	1.2.1.4.2	Current and future federal assets contributing to U.S. IOOS will continue to be managed by the offices that currently manage them. Some federal assets are managed by RAs. The management of federal assets that will be added to U.S. IOOS to enable full capability has not yet been identified, and their management cannot be described until they are identified by the gap analysis. (See Section 8 of the CARD for the development plan to "full capability.") Federal assets are being identified through a process of inventory, blueprint assessment, survey, and gap analysis. Federal assets will be added to this document as they are identified. Additionally, the number of people, the offices they represent, and the level of effort needed to manage the observing assets should be described in Section 4 of the CARD.
1.1.4.3 Non-federal assets	1.2.1.4.3	The RAs manage observing assets. They provide planning, oversight, and data input and output from the assets under their supervision. The RAs collect information about observing assets that may be added to their supervision and maintain information about the observing assets available in other RAs.
1.1.4.4 In Situ Observing Assets	1.2.1.5	In situ observing assets include fixed sensors, buoys, and platforms that remain in place to collect myriad coastal and ocean observation data required to inform foundational climate research, operational forecasting and warnings of immediate hazards, and regulatory decisions.
1.1.4.4.1 Moorings and Buoys	1.2.1.5.1	To collect long-term views of processes at work in the ocean, scientists and engineers have devised ways to leave instruments out in the environment. Moored observatories— secured by wires, buoys, weights, and floats—are platforms that allow observation of how the ocean and seafloor change. Common moorings use anchors and cables or ropes to secure boats, channel markers, and other floating objects in fixed places in our waterways. Fixed oceanographic moorings—also known as "Eulerian" platforms—work on the same principles, but the lines can be thousands of meters long and may or may not poke above the surface of the water. Scientific instruments can be attached to the mooring line, mounted on a surface buoy, or made to climb up and down the underwater line.
1.1.4.4.1.1 Central function	1.2.1.5.1.1	Buoy observing systems contribute to the purpose of gathering marine environment data. The central function coordinates integration of data provided by these systems into U.S. IOOS as defined in the Blueprint.
1.1.4.4.1.2 Federal assets	1.2.1.5.1.2	CARD Table 1-7 shows the currently identified inventory of federal buoys contributing to U.S. IOOS.
1.1.4.4.1.3 Non-federal assets	1.2.1.5.1.3	CARD Table 1-8 provides the currently known inventory of non-federal buoys contributing or expected to contribute to U.S. IOOS.
1.1.4.4.2 Fixed Stations	1.2.1.5.2	Fixed stations—broadly defined in this document as any observing station that is not a buoy—are monitoring platforms deployed at strategically located sites on beaches, marshlands, near-shore areas, or permanent structures such as meteorological stations and lighthouses. These stations are outfitted with observing instruments to gather a variety of marine environment data such as water quality, temperature, salinity, and chlorophyll.

Table 7.2-1. Work Breakdown Dictionary showing definition of functional areas by WBS identifier and functional responsibility.

Appendix C WBS	CARD System Config. Supporting Paragraph Reference	Definition
1.1.4.4.2.1 Central function	1.2.1.5.2.1	Fixed-station systems contribute to gathering marine environment data. The central function coordinates integration of data provided by these systems into U.S. IOOS as defined in the Blueprint.
1.1.4.4.2.2 Federal assets	1.2.1.5.2.2	CARD Table 1-9 provides the currently identified inventory of federal fixed stations that contribute to U.S. IOOS.
1.1.4.4.2.3 Non-federal assets	1.2.1.5.2.3	CARD Table 1-10 provides the current inventory of non-federal fixed stations that contribute to U.S. IOOS.
1.1.4.4.3 Undersea Imagery	1.2.1.5.3	Undersea imagery consists of transmitting live images from the seafloor to scientists ashore and to classrooms, newsrooms, and living rooms.
1.1.4.4.3.1 Central function	1.2.1.5.3.1	Undersea imagery systems contribute to gathering marine environment data. The central function coordinates integration of data provided by these systems into U.S. IOOS as defined in the Blueprint.
1.1.4.4.3.2 Federal assets	1.2.1.5.3.2	The federal partners will be asked to self-identify their observing assets. The description of their observing assets in this category should appear here. A partial list of the assets already identified is listed here. Appendix B contains details about the data collected, notably key parameters. Currently, the federal inventory of undersea imagery assets consists of the following NOAA-owned assets: Okeanos Explorer, a 224-foot former Naval surveillance T-AGOS Class ship Two remotely operated vehicles, attached by a tether, capable of operating to depths of 6,000 meters Five Exploration Command Centers ashore, receiving live images and other data from the seafloor over satellite and high-speed Internet pathways.
1.1.4.4.3.3 Non-federal assets	1.2.1.5.3.3	RAs support remote sensing by providing scientists to watch and interpret live imagery, around the clock if necessary. These opportunities for study of live undersea imagery are of short duration, e.g., for a week at a time, and represent a fraction of the non-federal assets' commitment. Additionally, there are some sustained towed vehicles that have been collecting data for a period of a year, and the data is being integrated by RAs.
1.1.4.5 Remote Observing Assets	1.2.1.6	Remote observing assets include satellite-, aircraft-, and land-based sensors, power sources, and transmitters.
1.1.4.5.1 High-Frequency Radar Arrays	1.2.1.6.1	The expanded implementation of the observing technology known as high frequency radar (HFR) is an example of successful and effective partnership among federal and regional IOOS components with benefits at the national and local levels. HFR systems collect data about ocean currents, including speed and direction, in near-real time. This information is needed to support a range of applications such as search and rescue (SAR), oil spill response, and assessment of beach water quality. This broad range of uses has motivated development of and support for a national network of surface-current mapping systems as part of U.S. IOOS.
1.1.4.5.1.1 Central function	1.2.1.6.1.1	The central function coordinates integration of data provided by these systems into U.S. IOOS as defined in the U.S. IOOS Blueprint.
1.1.4.5.1.2 Federal assets	1.2.1.6.1.2	NOAA CO-OPS owns and operates one HFR system in Cape Henry, VA.
1.1.4.5.1.3 Non-federal assets	1.2.1.6.1.3	CARD Table 1-11 identifies the operating entity and the inventory of HFR systems they manage.

Table 7.2-1. Work Breakdown Dictionary showing definition of functional areas by WBS identifier and functional responsibility.

Appendix C WBS	CARD System Config. Supporting Paragraph Reference	Definition
1.1.4.5.2 Satellites	1.2.1.6.2	Within NOAA the backbone of the satellites consists of the Geostationary Operational Environmental Satellite (GOES) and Polar-orbiting Operational Environmental Satellite (POES) systems. The Polar Acquisition Program consists of NOAA's POES system and the National Polar-orbiting Operational Environmental Satellite System (NPOESS) orbiting from north to south across the poles in three orbit planes to provide global coverage. POES is NOAA's current operational polar system and has one satellite remaining to launch in the current series, while NPOESS is the follow-on polar-orbiting satellite system.
1.1.4.5.2.1 Central function	1.2.1.6.2.1	The central function coordinates integration of data provided by these systems into U.S. IOOS as defined in the Blueprint.
1.1.4.5.2.2 Federal assets	1.2.1.6.2.2	Currently, 20 satellites are contributors or near-future contributors to U.S. IOOS. CARD Table 1-12 lists the federal asset inventory by satellite system.
1.1.4.5.2.3 Non-federal assets	1.2.1.6.2.3	Non-federal participants do not own or operate satellites that contribute to U.S. IOOS. Non-federal participants do operate downlinks that create quicker access to the data for users.
1.1.4.5.3 Aircraft	1.2.1.6.3	Aircraft provide scientists with airborne platforms necessary to collect environmental and geographic data.
1.1.4.5.3.1 Central function	1.2.1.6.3.1	The central function coordinates integration of data provided by these systems into U.S. IOOS as defined in the Blueprint.
1.1.4.5.3.2 Federal assets	1.2.1.6.3.2	CARD Table 1-13 provides the currently known inventory of federal aircraft contributing or identified to contribute to U.S. IOOS.
1.1.4.5.3.3 Non-federal assets	1.2.1.6.3.3	Currently no non-federal participants operate aircraft assets that contribute to U.S. IOOS.
1.1.4.6 Transitory Observing Assets	1.2.1.7	Transitory sensing assets include autonomous or remotely controlled underwater vehicles, such as gliders and remotely operated vehicles (ROVs) and ships with their associated sampling devices and transmitters.
1.1.4.6.1 Human Occupied Vehicles	1.2.1.7.1	Human occupied vehicles (HOVs) are submersibles that allow scientists to explore the deep ocean, far deeper than is possible by wet diving, due to the physiological restrictions on the human body.
1.1.4.6.1.1 Central function	1.2.1.7.1.1	The central function coordinates integration of data provided by these systems into U.S. IOOS as defined in the Blueprint.
1.1.4.6.1.2 Federal assets	1.2.1.7.1.2	The federal partners will be asked to self-identify their observing assets. A partial list of the assets that potentially may participate in IOOS is listed here. CARD Appendix B contains details about the data collected, notably key parameters. Submersibles owned by NOAA include Pisces IV and V, two of only nine submersibles in the world that can dive to depths of more than 6,562 feet. Both carry a pilot and two scientists. The submersibles are custom equipped to accommodate a variety of mission requirements. Standard gear includes external video and still cameras, two hydraulic manipulator arms, a conductivity/temperature/depth profiler, and sonar.
1.1.4.6.1.3 Non-federal assets	1.2.1.7.1.3	CARD Table 1-15 provides the identified inventory of nonfederal HOVs potentially contributing to U.S. IOOS. None of the RAs own HOVs. However, a few nonprofit organizations own and operate HOVs that are available for lease by RAs and could potentially participate as U.S. IOOS partners.

Table 7.2-1. Work Breakdown Dictionary showing definition of functional areas by WBS identifier and functional responsibility.

Appendix C WBS	CARD System Config. Supporting Paragraph Reference	Definition
1.1.4.6.2 Towed Underwater Vehicles	1.2.1.7.2	Towed underwater vehicles (TUVs) are devices that are dragged behind a ship to gather marine data by, for example, mapping seafloor bathymetry with sonar, taking pictures or video of the seafloor and marine life, and recording gravity and magnetics profiles of the oceanic crust.
1.1.4.6.2.1 Central function	1.2.1.7.2.1	The central function coordinates integration of data provided by these systems into U.S. IOOS as defined in the Blueprint.
1.1.4.6.2.2 Federal assets	1.2.1.7.2.2	CARD Table 1-16 provides the known inventory of federal TUV systems contributing or identified to contribute to U.S. IOOS.
1.1.4.6.2.3 Non-federal assets	1.2.1.7.2.3	Although a number of sensors can be affixed to a floating towed object for longitudinal study, few of the RAs have this capability. The single known regionally deployed towed sensor array, a side-scanning radar system, was deployed in Hawaii. The Hawaii Mapping Research Group deployed and operates one MR1 Towed Long Range Sidescan Sensor System.
1.1.4.6.3 Gliders	1.2.1.7.3	Gliders are robotic submarines that navigate underwater without a human crew onboard and without cables connecting them to research vessels at the sea surface. Figure 1-9 shows examples of gliders. These gliders carry a variety of sensors and are programmed by researchers to go wherever research is needed. They are used to take vertical profiles of data, giving scientists a clearer understanding of the temperature, salinity, and turbidity of specific areas of the oceans. These measurements are then used to determine and understand ocean circulation and its role and influence on the global climate. At the beginning and the end of each dive, the glider obtains and records its position by exposing a global positioning system (GPS) antenna. Researchers can then obtain data from the glider and send new instructions to it using a satellite phone system built into the glider. Gliders can provide a look at entire sections of ocean basins, as well as serve as virtual moorings by remaining at a single point. Unlike humans, who need to stop for breaks, gliders can carry out missions as long as 6 months in duration.
1.1.4.6.3.1 Central function	1.2.1.7.3.1	The central function coordinates integration of data provided by these systems into U.S. IOOS as defined in the Blueprint.
1.1.4.6.3.2 Federal assets	1.2.1.7.3.2	The U.S. Navy uses submarine-launched gliders to gather seawater temperature, salinity, water clarity, and ocean current speeds at various depths. It is not known whether this data is shared with U.S. IOOS.
1.1.4.6.3.3 Non-federal assets	1.2.1.7.3.3	CARD Table 1-17 shows the currently identified inventory of gliders that contribute to U.S. IOOS. The number of gliders available will undoubtedly increase, because they are inexpensive to buy and not difficult to make.

Table 7.2-1. Work Breakdown Dictionary showing definition of functional areas by WBS identifier and functional responsibility.

Appendix C WBS	CARD System Config. Supporting Paragraph Reference	Definition
1.1.4.6.4 Autonomous Underwater Vehicles	1.2.1.7.4	Autonomous underwater vehicles (AUVs), also known as unmanned underwater vehicles, can be used for underwater survey missions such as detecting and mapping submerged wrecks, rocks, and obstructions that pose a hazard to navigation for commercial and recreational vessels. The AUV conducts its survey mission without operator intervention. When a mission is complete, the AUV will return to a preprogrammed location and the data collected can be downloaded and processed in the same way as data collected by shipboard systems. AUVs can be equipped with a wide variety of oceanographic sensors or sonar systems. NOAA's hydrographic survey AUVs are typically equipped with side-scan sonar, Conductivity-Temperature-Depth (CTD) sensors, GPS-aided Inertial Navigation Systems (INSs), and an Acoustic Doppler Current Profiler (ADCP).
1.1.4.6.4.1 Central function	1.2.1.7.4.1	The central function coordinates integration of data provided by these systems into U.S. IOOS as defined in the Blueprint.
1.1.4.6.4.2 Federal assets	1.2.1.7.4.2	U.S. IOOS federal partners will be asked to self-identify their observing assets. Currently, no federal agencies are operating AUVs that may contribute to U.S. IOOS.
1.1.4.6.4.3 Non-federal assets	1.2.1.7.4.3	AUVs are an inexpensive alternative to manned observation. PacIOOS operates one REMUS AUV in the state of Hawaii. The Woods Hole Oceanographic Institute created the design for the AUVs and produces and manufactures several models, including the REMUS.
1.1.4.6.5 Remotely Operated Vehicles	1.2.1.7.5	ROVs are unoccupied, highly maneuverable underwater robots operated by a person aboard a surface vessel. They are linked to the ship by cables that carry electrical signals back and forth between the operator and the vehicle. Most are equipped with at least a video camera and lights. Equipment—such as a still camera, a manipulator or cutting arm, water samplers, and instruments that measure water clarity, light penetration, and temperature—is commonly added to expand the vehicle's capabilities.
1.1.4.6.5.1 Central function	1.2.1.7.5.1	The central function coordinates integration of data provided by these systems into U.S. IOOS as defined in the Blueprint.
1.1.4.6.5.2 Federal assets	1.2.1.7.5.2	No federal entities have been identified currently using or providing ROVs contributing to U.S. IOOS.
1.1.4.6.5.3 Non-federal assets	1.2.1.7.5.3	No non-federal entities have been identified currently using or providing ROVs contributing to U.S. IOOS. It is possible that ROVs could be leased by non-federal RAs to support U.S. IOOS.
1.1.4.6.6 Drifters and Floats	1.2.1.7.6	Drifter systems are devices that when released in the ocean, are left to the ocean currents for locomotion and destination. Devices are usually outfitted with radio or satellite beacons and GPS receivers, and the shapes of drifters can vary from cylinders to hardened, floating kites. Float systems are similar to drifters, in that they are built in various shapes and sizes, and they move horizontally with ocean currents, traveling long distances without the need of a ship, person, or propeller. But floats are also built to rise and fall vertically through the water. Simple mechanical pumps, bladders, and other devices are used to change the buoyancy of the float relative to the water, allowing it to bob between various depths. Modern floats are usually programmed to rise to the surface periodically in order to send data via satellite antenna to scientists on shore.

Table 7.2-1. Work Breakdown Dictionary showing definition of functional areas by WBS identifier and functional responsibility.

Appendix C WBS	CARD System Config. Supporting Paragraph Reference	Definition
1.1.4.6.6.1 Central function	1.2.1.7.6.1	The central function coordinates integration of data provided by these systems into U.S. IOOS as defined in the Blueprint.
1.1.4.6.6.2 Federal assets	1.2.1.7.6.2	One example lies in NOAA participation in the GOOS Global Drifter Program (GDP) through AOML and Scripps Institute of Oceanography. Some 1,250 GDPs have been deployed to map worldwide sea surface temperatures. NOAA operates a Drifter Data Assembly Center in Miami, FL. CARD Appendix B contains details about the data collected, notably key parameters. Environmental Monitors on Lobster Traps, or eMOLT, is a partnership involving NOAA, the Maine, Massachusetts, Downeast and Atlantic Offshore Lobstermen's Associations, the Gulf of Maine Lobster Foundation, and the Marine Science Department at Southern Maine Community College (SMCC) in Portland, Maine. The monitoring devices, which cost about $150 each, internally record temperature every hour around the clock while the pots are in the water. At the end of the season when the pots are hauled out, the instruments are removed and shipped back to Woods Hole Laboratory of the Northeast Fisheries Science Center (NEFSC), part of NOAA's Fisheries Service. The data is processed and loaded to the eMOLT web site. The data collected from temperature sensors on the lobster pots and from GPS surface drifters deployed as part of the eMOLT program help ocean circulation modelers better understand processes in the Gulf of Maine, such as how lobster larvae and other planktonic animals and plants, including those that cause harmful algal blooms, drift and settle. This information may also help determine how ocean currents disperse, condense and transport pollutants, as well as provide information about invasive species transport and measure plankton abundance.
1.1.4.6.6.3 Non-federal assets	1.2.1.7.6.3	Researchers who work for the NOAA GDP also support IOOS RAs. However, NOAA is the primary provider of drifter research. A nonprofit organization, Earth and Space Research (ESR), deploys, tracks, maintains, and operates drifters and floats. In the future these drifters and floats may provide some of the key IOOS parameters. Student researchers from local universities participate in drifter design, assembly, and deployment in the GoMOOS region.
1.1.4.6.7 Surveys	1.2.1.7.7	Hydrographic surveys are used to visualize the sea floor. Hydrographic surveys support a variety of activities: nautical charting, port and harbor maintenance (dredging), coastal engineering (beach erosion and replenishment studies), coastal zone management, and offshore resource development. The data are collected, processed, and stored digitally with specialized computer systems. Chart makers use the data, with shoreline information, to update nautical charts and generate graphical displays in both digital and hard-copy form.
1.1.4.6.7.1 Central function	1.2.1.7.7.1	The central function coordinates integration of data provided by these systems into U.S. IOOS as defined in the Blueprint.

Table 7.2-1. Work Breakdown Dictionary showing definition of functional areas by WBS identifier and functional responsibility.

Appendix C WBS	CARD System Config. Supporting Paragraph Reference	Definition
1.1.4.6.7.2 Federal assets	1.2.1.7.7.2	NOAA's Office of Coast Survey (OCS) conducts hydrographic surveys to measure the depth and bottom configuration of water bodies. OCS conducts hydrographic surveys primarily with side-scan and multibeam sonar. Some NOAA contractors employ LIDAR, which uses light to determine objects in the water and water depth. NOAA and its contractors usually complete 70 to 80 hydrographic surveys each year.
1.1.4.6.7.3 Non-federal assets	1.2.1.7.7.3	The RAs do not conduct surveys but can provide a portal for reporting the survey data in their region. AOOS hosts the data from airborne and USCG cutter Healy-hosted surveys.
1.1.4.6.8 Sampling	1.2.1.7.8	Sampling in the context of U.S. IOOS is defined as the taking of a representative sample of a given experimental population, which could include ocean water, marine species, sediment, and geologic material. An example of a deployable sampling system is a sediment trap. The basic sediment trap consists of a broad funnel with a collecting jar at the bottom. They can be deployed for only a few days at a time or up to a year and still collect useful samples.
1.1.4.6.8.1 Central function	1.2.1.7.8.1	The central function coordinates integration of data provided by these systems into U.S. IOOS as defined in the Blueprint.
1.1.4.6.8.2 Federal assets	1.2.1.7.8.2	Federal capabilities are not currently contributing to U.S. IOOS. The U.S. Army Corps of Engineers routinely dredges harbors and waterways to maintain shipping lanes, and it analyzes sediments obtained during those operations. The EPA also samples ocean sediments outside land effluents, particularly near industrial sites, for federal environmental compliance.
1.1.4.6.8.3 Non-federal assets	1.2.1.7.8.3	The RAs do not currently operate or maintain sediment traps. The Woods Hole Oceanographic Institute (WHOI) has an extensive sediment trap research, study, and publishing program. Brookhaven Institute also conducts sediment studies in the Atlantic Ocean.
1.1.4.6.9 Ships	1.2.1.7.9	NOAA's Office of Marine and Aviation Operations operates a wide assortment of hydrographic survey, oceanographic research, and fisheries research vessels. Ships located in the Pacific are managed by the Marine Operations Center, Pacific (MOP) in Seattle, WA. Ships located in the Atlantic are managed by the Marine Operations Center, Atlantic (MOA) in Norfolk, VA. Logistic support for the vessels is provided by the appropriate marine operations center or, for vessels in Woods Hole, Charleston, Pascagoula, San Diego, and Honolulu, by port captains located in those ports. The ships are run by a combination of NOAA commissioned officers and wage marine personnel, including licensed masters, mates, and engineers and unlicensed members of the engine, steward, and deck departments. In addition, survey and electronic technicians operate and maintain the ships' mission, communication, and navigation equipment. The ships' officers and crew provide mission support and assistance to embarked scientists from various NOAA laboratories as well as from the academic community.
1.1.4.6.9.1 Central function	1.2.1.7.9.1	The central function coordinates integration of data provided by these systems into U.S. IOOS as defined in the Blueprint. In addition, they serve in a key capacity for the deployment, retrieval, and ongoing maintenance of deployed observing systems.

Table 7.2-1. Work Breakdown Dictionary showing definition of functional areas by WBS identifier and functional responsibility.

Appendix C WBS	CARD System Config. Supporting Paragraph Reference	Definition
1.1.4.6.9.2 Federal assets	1.2.1.7.9.2	NOAA owns and operates 19 ships. CARD Table 1-18 lists NOAA and UNOLS ships, their owners, operators, and identifies their missions.
1.1.4.6.9.3 Non-federal assets	1.2.1.7.9.3	Currently, there is no comprehensive inventory of identified non-federal ships that contribute to U.S. IOOS. To meet ship-time requirements, NOAA uses, in addition to its own fleet, chartered ships from the University National Oceanographic Laboratory System (UNOLS) fleet, ships of opportunity, and ships provided by its foreign partners. RA s use ships and small boats for sampling, for observing asset maintenance, and to deploy and recover observational assets. This includes UNOLS ships, ships owned by various institutions such as oceanographic research institutes, and workboats and fishing boats chartered for operations and maintenance of in-water instrumentation.
1.1.5. Quality assurance and quality control on data	1.4?	The observing subsystem is responsible for data quality assurance/quality control (QA/QC) and for initial metadata generation for the measurements being made and transmitted. U.S. IOOS observing subsystem data collectors transmit their data from the sensor (hardware or human) to data providers such as ocean data assembly centers (DACs) and ocean data archive centers. Create, maintain, and modify quality assurance and quality control procedures that will be employed by U.S. IOOS participants.
1.1.5.1 Central function	N/A	The central function coordinates quality assurance and quality control of data into U.S. IOOS.
1.1.5.2 Federal assets	N/A	Federal organizations provide data quality assurance and control per IOOS guidelines for data supplied to the IOOS.
1.1.5.3 Non-federal assets	N/A	Non-federal organizations provide data quality assurance and control per IOOS guidelines for data supplied to the IOOS.
1.1.6. Transmission of data from assets to data provider data sets	N/A	This subsystem comprises the collection of sensor and non-sensor marine environment measurements and their transmission/conversion into data sets.
1.1.6.1 Central function	N/A	The central function coordinates provider data sets into U.S. IOOS.
1.1.6.2 Federal assets	N/A	Federal organizations provide data sets per IOOS guidelines for data supplied to the IOOS.
1.1.6.3 Non-federal assets	N/A	Non-federal organizations provide data sets per IOOS guidelines for data supplied to the IOOS.
1.2. DMAC	1.2.2, 2.3.2, 9.3	As described in the U.S. IOOS Blueprint, the DMAC subsystem will manage data provider and sponsored model participation and create, manage, and deliver IOOS DMAC-compliant data and utility services. Collective activities form the framework for the integration of both heterogeneous and independent DMAC systems (adapted from the DMAC Plan for Research and Operational Integrated Ocean Observing Systems, Ocean.US Publication 6, March 2005).
1.2.1. Registration and management of data providers	1.2.2.1–1.2.2.8	See 1.2.1.1–1.2.1.2

Table 7.2-1. Work Breakdown Dictionary showing definition of functional areas by WBS identifier and functional responsibility.

Appendix C WBS	CARD System Config. Supporting Paragraph Reference	Definition
1.2.1.1 Registration of data providers	1.2.2.1	As described in the U.S. IOOS Blueprint, this function will bring data providers, archives, or sponsored models into U.S. IOOS and facilitate proper categorization of their holdings to inform potential data/services customers of data availability, data quality, and metadata available. This activity includes certifying and adding data providers, archives, and sponsored models to the U.S. IOOS registry.
1.2.1.1.1 Central Function	1.2.2.1.1	
1.2.1.1.1.1 Certification	Table 1-19	Certify a data provider's DAC, archive, or sponsored model as DMAC compliant and gather the information needed to properly categorize their holdings for publication in the U.S. IOOS registry.
1.2.1.1.1.1.1 Observations Available	Table 1-19	Assess which core variables are available and their data structures and formats.
1.2.1.1.1.1.2 Data Quality	Table 1-19	Assess and categorize the data quality procedures used by the data provider, archive, or sponsored model.
1.2.1.1.1.1.3 Metadata	Table 1-19	Assess metadata available and the degree to which it conforms to U.S. IOOS minimum standards.
1.2.1.1.1.1.4 Update Latency	Table 1-19	Assess the latency between observations and the time they are available for transmission from the U.S. IOOS.
1.2.1.1.1.1.5 Refresh Frequency	Table 1-19	Assess how frequently data are refreshed.
1.2.1.1.1.1.6 Security	Table 1-19	Assess current security measures and identify additional security measures as required.
1.2.1.1.1.1.7 Access Rights	Table 1-19	Assess any limitations on who should be allowed to access data.
1.2.1.1.1.1.8 Archive Requirements	Table 1-19	Assess which data are archived, where archived, and for how long they will be accessible.
1.2.1.1.1.1.8.1 Standards to Be Employed	Table 1-19	Identify IOOS DMAC-compliant data standards to be employed.
1.2.1.1.1.1.8.2 Interface Requirements	Table 1-19	Assess how data users will access the data and whether the data provider needs to modify hardware or software.
1.2.1.1.1.1.8.3 Maturity Model Assessment	Table 1-19	Assess the "technology maturity" of the data provider, archive, or sponsored model in terms of the U.S. IOOS maturity model.
1.2.1.1.1.1.9 Certification Decision	Table 1-19	Make determinations to grant or deny certification pending specified actions being completed.
1.2.1.1.1.1.10 Complete MOA	Table 1-19	Create memorandums of agreement or service level agreements (SLAs) that detail the commitments made by the data provider, archive, sponsored model, and U.S. IOOS.
1.2.1.1.1.2 Registration	Table 1-19	Add the data provider's DAC, archive, or sponsored model to the U.S. IOOS registry.
1.2.1.1.1.2.1 Institute Usage Reporting	Table 1-19	Establish routine reporting from data provider, archive, and sponsored model's data usage on a predetermined schedule.
1.2.1.1.1.2.2 Add to Registry	Table 1-19	Update the U.S. IOOS registry to include new data providers, archives, and sponsored models; core variables served; data structures available; data quality; and metadata available.

Table 7.2-1. Work Breakdown Dictionary showing definition of functional areas by WBS identifier and functional responsibility.

Appendix C WBS	CARD System Config. Supporting Paragraph Reference	Definition
1.2.1.1.1.2.3 Notify Users	Table 1-19	Provide broad notification to U.S. IOOS partners, data/services customers, and internal U.S. IOOS offices that new data providers, archives, or sponsored models are available. The notification includes a recap of the registry information.
1.2.1.1.1.2.4 Installation Support	Table 1-19	Provide technical assistance to the data provider, archive, or sponsored model owner in setting up IOOS DMAC-compliant data services. This could include reference implementations, “how to” guides, and help desk support.
1.2.1.1.1.2.5 Reference Implementations	Table 1-19	Maintain a library of reference implementations for use by new data providers, archives, or sponsored models.
1.2.1.1.2 Federal Assets	1.2.2.1.2	Currently, the design of the federal contribution to DMAC is unknown.
1.2.1.1.3 Non-Federal Assets	1.2.2.1.3	Currently, the design of the non-federal contribution to DMAC is unknown.
1.2.1.2 Management of data providers	1.2.2.2	As described in the U.S. IOOS Blueprint, this function will manage DACs, archives, and sponsored models that are already U.S. IOOS providers.
1.2.1.2.1 Central Function	1.2.2.2.1	The Central Function coordinates management and collection of change requests required to manage updates, configuration control, and changes to the hardware and software of the U.S. IOOS.
1.2.1.2.1.1 Change Request	Table 1-20	Change registry, interface, or any other aspect of the relationship between the data provider, archive, or sponsored model owner and U.S. IOOS.
1.2.1.2.1.1.1 Receive Change Request	Table 1-20	Accept, log, and process change requests initiated by a data provider, archive, or sponsored model owner.
1.2.1.2.1.1.2 Evaluate Request	Table 1-20	Evaluate change requests to see if they are reasonable, supportable, and determine any impacts on the system.
1.2.1.2.1.1.3 Approve Request	Table 1-20	Approve change requests.
1.2.1.2.1.1.4 Publish Notifications	Table 1-20	Publish notification of an impending change and effective date to the requesting data provider, archive, or sponsored model owner and to U.S. IOOS internal and data/services customers.
1.2.1.2.1.1.5 Make Changes	Table 1-20	Implement change requests as scheduled.
1.2.1.2.1.2 Cyclic Review	Table 1-20	Review participating DACs, archives, and sponsored models on a recurring basis. The time between reviews may be different depending on the unique aspects of each data provider’s participation.
1.2.1.2.1.2.1 Identify Required Changes	Table 1-20	Change the registry or make other changes identified in the cyclic review and negotiated with a data provider, archive, or sponsored model owner.
1.2.1.2.1.2.2 Approve Changes	Table 1-20	Evaluate changes to determine if they are reasonable and supportable and determine their impacts.
1.2.1.2.1.2.3 Make Changes	Table 1-20	Implement changes that result from cyclic reviews.
1.2.1.2.1.2.4 Publish Notifications	Table 1-20	Publish notification of an impending change and effective date to the requesting data provider, archive, sponsored model owner, and to U.S. IOOS internal and data/services customers.
1.2.1.2.1.3 Monitor	Table 1-20	Monitor the U.S. IOOS network to ensure functionality and identify problems.

Table 7.2-1. Work Breakdown Dictionary showing definition of functional areas by WBS identifier and functional responsibility.

Appendix C WBS	CARD System Config. Supporting Paragraph Reference	Definition
1.2.1.2.1.3.1 Monitor Usage	Table 1-20	Monitor customer interest via by monitoring registry and catalog requests.
1.2.1.2.1.3.2 Monitor Availability	Table 1-20	Check on the availability of data provider (DACs, archives, and sponsored models) offerings in U.S. IOOS.
1.2.1.2.1.3.3 Review Reports	Table 1-20	Review data provider (DACs, archives, and sponsored models) utilization reports.
1.2.1.2.1.3.4 Data Provider Help Desk	Table 1-20	Provide technical assistance to data providers (DACs, archives, and sponsored models) in isolating and resolving issues.
1.2.1.2.1.4 Update	Table 1-20	Periodically update data provider (DACs, archives, sponsored models) certification and registration information
1.2.1.2.1.4.1 Update Certification	Table 1-20	Update existing certifications and assessments.
1.2.1.2.1.4.2 Update Registry	Table 1-20	Update registry information.
1.2.1.2.1.4.3 Update MOA	Table 1-20	Update existing MOAs/SLAs for reissue.
1.2.1.2.1.4.4 Update Services	Table 1-20	Create change requests for existing IOOS DMAC- compliant data and utility services.
1.2.1.2.1.5 Capability Assessments	Table 1-20	Assess the composite capability of the U.S. IOOS participating data providers' DACs, archives, and sponsored models in light of existing requirements and future plans.
1.2.1.2.2 Federal Assets	1.2.2.2.2	Currently, this DMAC function is being updated. NSF has an infrastructure that may contribute to this function.
1.2.1.2.3 Non-Federal Assets	1.2.2.2.3	Currently, there is no non-federal contribution to this DMAC function.
1.2.1.3 Deregistration of data providers	1.2.2.3	As described in the U.S. IOOS Blueprint, this function will remove a data provider (DAC, archive, sponsored model) from U.S. IOOS if/when circumstances dictate.
1.2.1.3.1 Central Function	1.2.2.3.1	Deregistration of data providers is a requisite central function.
1.2.1.3.1.1 Request to deregister	Table 1-21	Allow data providers (DAC, archive, sponsored model owners) to request removal from U.S. IOOS. The request may also be generated as a result of U.S. IOOS monitoring and quality control efforts.
1.2.1.3.1.1.1 Receive Request	Table 1-21	Receive, log, and process requests to deregister a data provider.
1.2.1.3.1.1.2 Approval	Table 1-21	Approve deregistration requests.
1.2.1.3.1.2 Notice to data provider	Table 1-21	Notify the affected data provider (DAC, archive, or sponsored model owner) of the intent to remove their data from the U.S. IOOS
1.2.1.3.1.2.1 Create Notice	Table 1-21	Create a notice to the data provider (DAC, archive, or sponsored model owner) citing the reasons for removal and the effective date.
1.2.1.3.1.2.2 Transmission	Table 1-21	Transmit removal notice to the data provider.
1.2.1.3.1.2.3 Approval	Table 1-21	Adjudicate and approve the decision to remove a data provider (DAC, archive, or sponsored model owner) from U.S. IOOS.
1.2.1.3.1.2.4 Reconsideration	Table 1-21	Allow a data provider (DAC, archive, or sponsored model owner) to request reconsideration of a deregistration action.

Table 7.2-1. Work Breakdown Dictionary showing definition of functional areas by WBS identifier and functional responsibility.

Appendix C WBS	CARD System Config. Supporting Paragraph Reference	Definition
1.2.1.3.1.2.5 Final Approval	Table 1-21	Provide final approval or disapproval of removal decisions after review of requests for reconsideration.
1.2.1.3.1.3 Notice to users	Table 1-21	Provide notice to data/services customers and internal U.S. IOOS offices of the impending deregistration action.
1.2.1.3.1.3.1 Create Notice	Table 1-21	Create notification materials.
1.2.1.3.1.3.2 Approval	Table 1-21	Approve notices for publication.
1.2.1.3.1.3.3 Publish	Table 1-21	Publish notice of deregistration of a data provider (DAC, archive, or sponsored model) to data/services customers and internal U.S. IOOS offices.
1.2.1.3.1.3.4 Respond to Inquiries	Table 1-21	Respond to Inquiries—Respond to inquiries from affected data/services customers based on deregistration of a data provider.
1.2.1.3.1.4 Adjustment to products and services	Table 1-21	Make changes to DMAC utility services and sponsored models that are affected by the decision to deregister a data provider DAC, archive, or sponsored model.
1.2.1.3.1.4.1 Identify Changes	Table 1-21	Identify all changes to DMAC utility services and sponsored models that are required by a deregistration action. Approve the changes to DMAC utility services and sponsored models that are required by a deregistration action.
1.2.1.3.1.4.2 Approve Changes	Table 1-21	Approve the changes to DMAC utility services and sponsored models that are required by a deregistration action.
1.2.1.3.1.4.3 Make Changes	Table 1-21	Implement the changes to DMAC utility services and sponsored models that are required by a deregistration action.
1.2.1.3.1.4.4 Testing	Table 1-21	Test DMAC utility services and sponsored models to ensure changes required by a deregistration action were properly applied and the services and models are functioning correctly.
1.2.1.3.1.4.5 Update Configuration and Control Documents	Table 1-21	Ensure configuration control documentation is updated after a deregistration action.
1.2.1.3.1.5 Deregister	Table 1-21	Remove a data providers (DAC, archive, or sponsored model owner) information/data from the U.S. IOOS registry.
1.2.1.3.1.5.1 Update Registry	Table 1-21	Ensure that the U.S. IOOS registry reflects the registration and all other changes made as a result of deregistration.
1.2.1.3.1.5.2 Archive Documents	Table 1-21	Archive all documentation associated with a deregistration action.
1.2.1.3.2 Federal Assets	1.2.2.3.2	Currently, this DMAC function is being updated.
1.2.1.3.3 Non-Federal Assets	1.2.2.3.3	Currently, this DMAC function is being updated.
1.2.2. IT infrastructure	1.2.4.8.1	Infrastructure that enables the interoperable transmission of marine environment data from a data provider (U.S. IOOS observing subsystem) to a data/services customer (e.g., U.S. IOOS modeling and analysis subsystem).

Table 7.2-1. Work Breakdown Dictionary showing definition of functional areas by WBS identifier and functional responsibility.

Appendix C WBS	CARD System Config. Supporting Paragraph Reference	Definition
1.2.2.1 Desktop management	1.2.4.8.1	Infrastructure for office IT services, including hardware, software, and help desk support. These services include desktop computers, printers, laptops, backups, COOP, hand-held devices, and other computer resources that interface with individuals.
1.2.2.2 Network management	1.2.4.8.1	Infrastructure for the U.S. IOOS-owned network, including cabling, servers, routers, bridges, gateways, etc. Due to the nature of computer networks, there is no differentiation between the network to support internal U.S. IOOS office needs and the network that provides DMAC services. The network will likely be a composite of owned, leased, and partner-provided assets.
1.2.2.3 Architecture management	1.2.4.8.1	Infrastructure for the IT architecture, including internal, network, and DMAC, to ensure effectiveness, efficiency, and compliance with federal and other standards. DMAC—Manage IT services, including hardware, software, and help desk support related to the delivery of IOOS DMAC-compliant data and utility services. IOOS Program Internal—Manage IT services, including hardware, software, and help desk support related to the U.S. IOOS Program Office user needs.
1.2.2.4 Website management	1.2.4.8.1	Infrastructure for the U.S. IOOS website, including technical and content management.
1.2.3. Configuration control	1.2.2.9	As described in the U.S. IOOS Blueprint, this function will ensure that all aspects of U.S. IOOS software development and IT life- cycle management have proper configuration control and documentation.
1.2.3.1 Central Function	1.2.2.9.1	Configuration control is a requisite central function.
1.2.3.1.1 Review documentation	Table 1-27	Review U.S. IOOS IT configuration control documentation to ensure that it is current.
1.2.3.1.2 Update documentation	Table 1-27	Update IT configuration control documentation when changes are required.
1.2.3.2 Federal Assets	1.2.2.9.2	No federal assets are associated with this function.
1.2.3.3 Non Federal Assets	1.2.2.9.3	No non-federal assets are associated with this function.
1.2.4. Input-output management	1.2.4	Collection and configuration management of inputs and outputs under configuration control for the DMAC.
1.2.5. Provide repository (data, metadata, archives)	1.2.5	Provide central repository for data from DAC, archive, or sponsored models.
1.2.5.1 Utility Services	1.2.5	Assess utility tools for visualization, interpretation, and statistical analysis of DAC, archive, or sponsored model outputs.
1.2.5.1.1 Utility Services Management	1.2.2.5	As described in the U.S. IOOS Blueprint, this function will manage and maintain the development and delivery of U.S. IOOS DMAC utility services (services that manipulate data to provide a value-added service as distinct from “data services,” which function to enable delivery of DMAC-compliant ocean observing data and model outputs).
1.2.5.1.1.1 Central Function	Table 1-23	Utility services management is a requisite central function.
1.2.5.1.1.1.1 Service Registry	Table 1-23	Create and maintain the central records that allow data discovery and inform users of the core variables, data structures, metadata, and quality of U.S. IOOS data providers as well as how to access and use them.

Table 7.2-1. Work Breakdown Dictionary showing definition of functional areas by WBS identifier and functional responsibility.

Appendix C WBS	CARD System Config. Supporting Paragraph Reference	Definition
1.2.5.1.1.1.1.1 Add New	Table 1-23	Add new records to the registry.
1.2.5.1.1.1.1.2 Delete Old	Table 1-23	Delete antiquated records from the registry.
1.2.5.1.1.1.1.3 Modify Entries	Table 1-23	Modify existing registry entries.
1.2.5.1.1.1.2 Data Catalog Service	Table 1-23	Create catalogs derived from the registry and other documentation. Catalogs provide simplified and enhanced means for U.S. IOOS data/services customers to find the kinds of data or services they need.
1.2.5.1.1.1.2.1 Establish Services	Table 1-23	Create and publish new catalogs.
1.2.5.1.1.1.2.2 Maintain Service	Table 1-23	Maintain accuracy and availability of catalogs.
1.2.5.1.1.1.2.3 Evaluate Service	Table 1-23	Evaluate the usefulness of existing catalogs and to determine the need for new catalogs.
1.2.5.1.1.1.2.4 Disestablish Service	Table 1-23	Remove unneeded catalogs from use.
1.2.5.1.1.1.3 Data Integration Service	Table 1-23	Develop and maintain data integration services. (Some data will require aggregation from multiple data sources in support of customer needs, or as an intermediate product in support of other U.S. IOOS services.) If required, data translation may be part of this service.
1.2.5.1.1.1.3.1 Receive Requests	Table 1-23	Receive and record requests from data/utility services customers for data integration service.
1.2.5.1.1.1.3.2 Evaluate Requests	Table 1-23	Evaluate data integration related requests for current sources or to determine if development is needed.
1.2.5.1.1.1.3.3 Approval	Table 1-23	Approve or disapprove access to existing data integration services or to approve request to develop new data integration services.
1.2.5.1.1.1.3.4 Establish Services	Table 1-23	Implement access to existing data integration services.
1.2.5.1.1.1.3.5 Maintain Service	Table 1-23	Perform routine maintenance of data integration service software and hardware.
1.2.5.1.1.1.3.6 Evaluate Service	Table 1-23	Evaluate data integration service usage, reliability, cost, and performance.
1.2.5.1.1.1.3.7 Disestablish Service	Table 1-23	Shut down unneeded data integration services.
1.2.5.1.1.1.4 Mapping and visualization service	Table 1-23	Provide data as a visual and/or mapping display that supports data/utility services customer needs. For example, data from multiple data providers may be combined and displayed in the form of color-coded maps to support customer needs
1.2.5.1.1.1.4.1 Receive Requests	Table 1-23	Receive and record requests from data/utility services customers to access mapping and visualization services.
1.2.5.1.1.1.4.2 Evaluate Requests	Table 1-23	Evaluate requests for mapping and visualization services to determine existing sources or the need to develop new mapping and visualization services.

Table 7.2-1. Work Breakdown Dictionary showing definition of functional areas by WBS identifier and functional responsibility.

Appendix C WBS	CARD System Config. Supporting Paragraph Reference	Definition
1.2.5.1.1.1.4.3 Approval	Table 1-23	Approve or disapprove access to existing mapping and visualization services or to approve request to develop new mapping and visualization services.
1.2.5.1.1.1.4.4 Establish Services	Table 1-23	Implement the mapping and visualization displays and make appropriate changes to the registry and catalogs, and inform the requesting data/utility services customer.
1.2.5.1.1.1.4.5 Maintain Service	Table 1-23	Maintain existing mapping and visualization services.
1.2.5.1.1.1.4.6 Evaluate Service	Table 1-23	Evaluate usage and quality of mapping and visualization services.
1.2.5.1.1.1.4.7 Disestablish Service	Table 1-23	Delete mapping and visualization display products, including notification to users and changes to the registry and catalogs.
1.2.5.1.1.1.5 Product generation services	Table 1-23	Support provision of services that provide derived products such as statistical analyses and feature extractions from data.
1.2.5.1.1.1.5.1 Receive Requests	Table 1-23	Receive product generation requests from data/utility services customers.
1.2.5.1.1.1.5.2 Evaluate Requests	Table 1-23	Ensure that product generation requests can be accommodated in terms of data availability and that the requested information will properly support the intent of the requestor.
1.2.5.1.1.1.5.3 Approval	Table 1-23	Approve product generation requests from data/utility services customers.
1.2.5.1.1.1.5.4 Establish Services	Table 1-23	Deliver product generation services for data/utility services customers.
1.2.5.1.1.1.5.5 Maintain Service	Table 1-23	Maintain product generation services.
1.2.5.1.1.1.5.6 Evaluate Service	Table 1-23	Ensure quality control and evaluate usage of product generation services.
1.2.5.1.1.1.5.7 Disestablish Service	Table 1-23	Remove data/utility services customers from product generation services or to shut down a particular service.
1.2.5.1.1.1.6 Format conversion service	Table 1-23	Support provision of a utility service that allows translation of data from one format to another. Unlike data access services that allow users to access data regardless of the source, this service fundamentally changes the data format into a format more convenient for the data/utility services customer. (Examples of format conversions include XML to NetCDF or GML to KML.)
1.2.5.1.1.1.6.1 Receive Requests	Table 1-23	Receive requests for format conversion utility services.
1.2.5.1.1.1.6.2 Evaluate Requests	Table 1-23	Determine if existing format conversion services are adequate, or if modified, whether new services are required.
1.2.5.1.1.1.6.3 Approval	Table 1-23	Approve requests to access existing format conversion services, modify the services, or develop new services.
1.2.5.1.1.1.6.4 Establish Services	Table 1-23	Set up data/utility services customer access to a format conversion service.
1.2.5.1.1.1.6.5 Maintain Service	Table 1-23	Maintain format conversion services.

Table 7.2-1. Work Breakdown Dictionary showing definition of functional areas by WBS identifier and functional responsibility.

Appendix C WBS	CARD System Config. Supporting Paragraph Reference	Definition
1.2.5.1.1.1.6.6 Evaluate Service	Table 1-23	Evaluate the quality of format conversion services and evaluate usage.
1.2.5.1.1.1.6.7 Disestablish Service	Table 1-23	Remove data/utility services customers from access to a format conversion service or shut down a service.
1.2.5.1.1.1.7 Coordinate transformation services	Table 1-23	Support provision of services that convert between different geographic coordinate systems (e.g., from latitude/longitude to Mercator), between different measurement axes (e.g., from northward and eastward components of wind to wind speed and direction), or between different units of measure (e.g., from Celsius to Fahrenheit).
1.2.5.1.1.1.7.1 Establish Services	Table 1-23	Set up coordinate transformation services.
1.2.5.1.1.1.7.2 Maintain Service	Table 1-23	Maintain and modify coordinate transformation services.
1.2.5.1.1.1.7.3 Evaluate Service	Table 1-23	Monitor quality and usage of coordinate transformation services.
1.2.5.1.1.1.7.4 Disestablish Service	Table 1-23	Shut down unneeded coordinate transformation services.
1.2.5.1.1.1.8 Workflow services	Table 1-23	Support provision of services that enable customers to chain together multiple processing steps to produce the desired output. For example, get data from the source, convert to another format, compute polygonal boundary of observed phenomenon, then produce an image of the result
1.2.5.1.1.1.8.1 Receive Requests	Table 1-23	Receive requests for workflow services.
1.2.5.1.1.1.8.2 Evaluate Requests	Table 1-23	Determine if existing workflow services are adequate, or if modified, whether new workflow services are required.
1.2.5.1.1.1.8.3 Approval	Table 1-23	Approve requests to access existing workflow services, modify the services, or develop new workflow services.
1.2.5.1.1.1.8.4 Establish Services	Table 1-23	Set up customer access to workflow services.
1.2.5.1.1.1.8.5 Maintain Service	Table 1-23	Maintain workflow services.
1.2.5.1.1.1.8.6 Evaluate Service	Table 1-23	Evaluate the quality of workflow services and evaluate usage.
1.2.5.1.1.1.8.7 Disestablish Service	Table 1-23	Remove customers from access to workflow services or shut down a workflow service.
1.2.5.1.1.2 Federal Assets	1.2.2.5.2	Currently, a number of federal partners are providing data functions to the DMAC, including NOAA OAR & NOAA NDBC.
1.2.5.1.1.3 Non-Federal Assets	1.2.2.5.3	Non-Federal partners provide data collection and assembly to the DMAC functions.
1.2.5.1.2 Utility Services Development	1.2.2.6	As described in the U.S. IOOS Blueprint, this function will develop new utility service offerings, or improve existing DMAC utility services.
1.2.5.1.2.1 Central Function	1.2.2.6.1	Utility services development is a requisite central function.

Table 7.2-1. Work Breakdown Dictionary showing definition of functional areas by WBS identifier and functional responsibility.

Appendix C WBS	CARD System Config. Supporting Paragraph Reference	Definition
1.2.5.1.2.1.1 Quality monitor existing services	Table 1-24	Monitor the quality of the existing set of DMAC utility services to inform improvement decisions.
1.2.5.1.2.1.1.1 Sampling	Table 1-24	Provide quality sampling by humans of existing utility services.
1.2.5.1.2.1.1.2 Automated Monitoring	Table 1-24	Automatically monitor existing services.
1.2.5.1.2.1.1.3 User Surveys	Table 1-24	Conduct surveys of utility service customers to identify needed improvements.
1.2.5.1.2.1.2 Assess service requirements	Table 1-24	Assess requirements for new utility services derived from the monitoring efforts.
1.2.5.1.2.1.2.1 Priority	Table 1-24	Prioritize utility service requirements in terms of importance.
1.2.5.1.2.1.2.2 Cost	Table 1-24	Determine cost of proposed utility service changes.
1.2.5.1.2.1.2.3 Technical Solution	Table 1-24	Develop a technical solution to satisfy utility service requirements.
1.2.5.1.2.1.2.4 Time	Table 1-24	Determine time required to implement utility service changes.
1.2.5.1.2.1.2.5 Cost Benefit	Table 1-24	Determine cost-benefit of proposed utility service changes.
1.2.5.1.2.1.3 Approve changes	Table 1-24	Approve utility service development efforts and integrate work into existing schedules.
1.2.5.1.2.1.3.1 Approve	Table 1-24	Approve utility service changes.
1.2.5.1.2.1.3.2 Schedule	Table 1-24	Integrate work into existing utility service plans.
1.2.5.1.2.1.4 Execute Changes	Table 1-24	Make utility service changes to test servers.
1.2.5.1.2.1.5 Testing	Table 1-24	Test new utility services.
1.2.5.1.2.1.6 Notification	Table 1-24	Notify data/utility services customers and internal U.S. IOOS offices of pending release of new utility services.
1.2.5.1.2.1.7 Deployment	Table 1-24	Roll out new utility services for U.S. IOOS DMAC.
1.2.5.1.2.2 Federal Assets	1.2.2.6.2	Currently, this DMAC function is being updated.
1.2.5.1.2.3 Non Federal Assets	1.2.2.6.3	Non-Federal partners provide data collection and assembly to the DMAC functions.
1.2.5.2 Data Services	1.2.2.7	As described in the Blueprint, this function will provide a DMAC capable of delivering real-time and non-real time observations to a wide variety of users.
1.2.5.2.1 Data Services and Component Development	1.2.2.7	As described in the U.S. IOOS Blueprint, this function will adopt, modify, or develop IOOS DMAC-compliant data services and components.
1.2.5.2.1.1 Central Function	1.2.2.7.1	Data services and component development is a requisite central function.
1.2.5.2.2.1.1 Quality monitor existing services	Table 1-25	Monitor the quality of the existing IOOS DMAC-compliant data services and components to inform improvement decisions.
1.2.5.2.2.1.1.1 Sampling	Table 1-25	Provide human sampling of existing IOOS DMAC- compliant data services and components.

Table 7.2-1. Work Breakdown Dictionary showing definition of functional areas by WBS identifier and functional responsibility.

Appendix C WBS	CARD System Config. Supporting Paragraph Reference	Definition
1.2.5.2.2.1.1.2 Automated Monitoring	Table 1-25	Automatically monitor existing IOOS DMAC-compliant data services and components.
1.2.5.2.2.1.1.3 User Surveys	Table 1-25	Conduct surveys of IOOS DMAC-compliant data service and component customers to identify needed improvements.
1.2.5.2.2.1.2 Assess service requirements	Table 1-25	Assess requirements for new IOOS DMAC-compliant data services and components derived from the monitoring efforts.
1.2.5.2.2.1.2.1 Priority	Table 1-25	Prioritize IOOS DMAC-compliant data service and component requirements in terms of importance.
1.2.5.2.2.1.2.2 Cost	Table 1-25	Determine cost of proposed IOOS DMAC-compliant data service and component changes.
1.2.5.2.2.1.2.3 Technical Solution	Table 1-25	Develop a technical solution to satisfy IOOS DMAC-compliant data service and component requirements.
1.2.5.2.2.1.2.4 Time	Table 1-25	Determine time required to implement IOOS DMAC-compliant data service and component changes.
1.2.5.2.2.1.2.5 Cost Benefit	Table 1-25	Determine cost-benefit of proposed IOOS DMAC-compliant data service and component changes.
1.2.5.2.2.1.3 Approve changes	Table 1-25	Approve IOOS DMAC-compliant data service and component development efforts and integrate work into existing schedules.
1.2.5.2.2.1.3.1 Approve	Table 1-25	Approve IOOS DMAC-compliant data service and component changes.
1.2.5.2.2.1.3.2 Schedule	Table 1-25	Integrate work into existing IOOS DMAC-compliant data service and component plans.
1.2.5.2.2.1.4 Execute Changes	Table 1-25	Make IOOS DMAC-compliant data service and component changes to test servers.
1.2.5.2.2.1.5 Testing	Table 1-25	Test new IOOS DMAC-compliant data services and components.
1.2.5.2.2.1.6 Notification	Table 1-25	Notify customers and internal U.S. IOOS offices of pending release of new IOOS DMAC-compliant data services and components.
1.2.5.2.2.1.7 Deployment	Table 1-25	Roll out new IOOS DMAC-compliant data services and components for U.S. IOOS DMAC. Several federal partners are working to contribute to the DMAC. Several already contribute data in compliant formats. The format of this function is being updated.
1.2.5.2.1.2 Federal Assets	1.2.2.7.2	Several federal partners are working to contribute to the DMAC. Several already contribute data in compliant formats. The format of this function is being updated.
1.2.5.2.1.3 Non-Federal Assets	1.2.2.7.3	Operators of ocean observing assets are responsible for transmitting their data to an IOOS DAC (federal, regional, or other DMAC-capable site). The RAs are key providers of observing assets and data transmission services.
1.2.5.2.2 Data Services and Component Management	1.2.2.8	As described in the U.S. IOOS Blueprint, this function will manage and maintain existing IOOS DMAC-compliant data services and perform component management.
1.2.5.2.2.1 Central Function	1.2.2.8.1	As described in the Blueprint, this function manages and maintains existing IOOS DMAC-compliant data services and performs component management.

Table 7.2-1. Work Breakdown Dictionary showing definition of functional areas by WBS identifier and functional responsibility.

Appendix C WBS	CARD System Config. Supporting Paragraph Reference	Definition
1.2.5.2.2.1.1 Data Access Services	Table 1-26	Manage services that allow customers to "pull" data on request from data assembly centers. Different data types may require different services, and a variety of services may be offered to satisfy different customers, but all data access services are expected to enable the customer to (1) make an explicit request at the moment of need and (2) specify the desired subset of the data based on the location of interest, the time of interest, and possibly other subset criteria.
1.2.5.2.2.1.2 Data subscriptions and alerts services	Table 1-26	Manage services that inform customers of various types about changes in the U.S. IOOS, model outputs, data provider offerings, quality or metadata, etc. The customers are grouped into lists that receive notifications when news of interest to that category of customer occurs. The notifications may be administrative, such as changes in a data provider's data offerings, or data- related, such as the temperature in a specific location has peaked above a specified level. This utility service will have two functions: (1) a subscription service that allows a user to access information on a particular topic area, and (2) an alert service that allows users to define data of interest and thresholds. When the data or combined data exceed these thresholds, the users will receive notification automatically.
1.2.5.2.2.1.3 System viewer component	Table 1-26	Support provision of the component that provides a web-based user inter-face to the data catalog and the service registry. It allows humans to issue searches for data using map-based or form-based query interface, it dis-plays results of searches in either map or tabular form, and it provides links to the actual data and metadata corresponding to the search results.
1.2.5.2.2.1.4 System monitor component	Table 1-26	Support management of the component that enables monitoring of the status of DMAC services. Monitoring allows the U.S. IOOS to identify problems and take action to resolve issues. Monitoring may also include gathering of usage statistics if data searches and request are made via an U.S. IOOS catalog or viewer. However, because data requests may go directly to the data providers, this monitoring service will not provide a complete view of system usage.
1.2.5.2.2.2 Federal Assets	1.2.2.8.2	Currently, the federal contribution to this DMAC function has not been completely defined.
1.2.5.2.2.3 Non-Federal Assets	1.2.2.8.3	The non-federal partners will receive assistance and guidance from the Central Function to implement these sub-activities.
1.2.6. Protocols and standards	1.2.2.4	
1.2.6.1 Standards Management	1.2.2.4	As described in the U.S. IOOS Blueprint, this function will manage U.S. IOOS standards, including IOOS DMAC-compliant data services.
1.2.6.1.1 Central Function	1.2.2.4.1	The Central Function manages the standards for data and quality control through standards assessment, development, and maintenance. Additionally, interfaces, dictionaries, and catalogs are also coordinated through this function.
1.2.6.1.1.1 Standards Assessment	Table 1-22	Evaluate U.S. IOOS standards and to develop standards requirements

Table 7.2-1. Work Breakdown Dictionary showing definition of functional areas by WBS identifier and functional responsibility.

Appendix C WBS	CARD System Config. Supporting Paragraph Reference	Definition
1.2.6.1.1.1.1 Assess Efficiency and Effectiveness of Current Standards	Table 1-22	Assess efficiency and effectiveness of U.S. IOOS standards.
1.2.6.1.1.1.2 Monitor Evolution of Standards	Table 1-22	Keep track of proposed changes in open standards proposed by standards bodies.
1.2.6.1.1.1.3 Create Requirements for New or Modified Standards	Table 1-22	Define requirements for U.S. IOOS standards.
1.2.6.1.1.1.4 Standards Release Planning	Table 1-22	Determine the optimum time for the release of new or improved U.S. IOOS standards to ensure synchronized application.
1.2.6.1.1.2 Standards development	Table 1-22	Adopt, adapt, or develop new U.S. IOOS standards.
1.2.6.1.1.2.1 Requirements Analysis	Table 1-22	Analyze requirements for new U.S. IOOS standards.
1.2.6.1.1.2.2 Solution Development	Table 1-22	Adopt, adapt, or create new U.S. IOOS standards as required.
1.2.6.1.1.2.3 Testing	Table 1-22	Test the proposed new U.S. IOOS standards to ensure that they work as intended and meet U.S. IOOS requirements.
1.2.6.1.1.2.4 Approval	Table 1-22	Approve implementation of new U.S. IOOS standards as part of U.S. IOOS DMAC.
1.2.6.1.1.3 Existing standards maintenance	Table 1-22	Maintain DMAC standards in use.
1.2.6.1.1.3.1 Assess Change Requests	Table 1-22	Receive, record, and evaluate requests for changes to published DMAC standards.
1.2.6.1.1.3.2 Approve Changes	Table 1-22	Approve requests to change existing DMAC standards, including timing of releases, to help manage impacts of the changes.
1.2.6.1.1.3.3 Make Changes	Table 1-22	Implement the approved changes to DMAC standards.
1.2.6.1.1.3.4 Testing	Table 1-22	Test changes to ensure that they were properly applied and the results meet expectations.
1.2.6.1.1.3.5 Publish Change	Table 1-22	Publish changes to data providers, archives, and sponsored model owners (IOOS DMAC-compliant data services) and to other interested parties.
1.2.6.1.1.4 Interface management	Table 1-22	Manage creation and publishing of solutions to meet specific or unique data/services customers' data interface requirements to allow their interfaces to communicate with IOOS DMAC-compliant data and utility services.
1.2.6.1.1.4.1 Identify Interface Requirements	Table 1-22	Collect interface requirements from data/services customers.
1.2.6.1.1.4.2 Identify Solutions	Table 1-22	Identify and publish solution software, documentation, and procedures to meet data/services customer interface requirements.
1.2.6.1.1.4.3 Document Solutions	Table 1-22	Catalog and retain solution documentation for reference and reuse by other data/services customers.

Table 7.2-1. Work Breakdown Dictionary showing definition of functional areas by WBS identifier and functional responsibility.

Appendix C WBS	CARD System Config. Supporting Paragraph Reference	Definition
1.2.6.1.1.5 Dictionaries and catalogs	Table 1-22	Control development and maintenance of U.S. IOOS dictionaries and catalogs to facilitate easy discovery of U.S. IOOS data and model outputs and to provide a standard set of references to ensure uniform application of terminology and metrics across the U.S. IOOS.
1.2.6.1.1.5.1 Controlled Vocabularies	Table 1-22	Create and maintain controlled vocabularies that provide a uniform meaning for terminology across the U.S. IOOS in terms of ocean science and IT supporting documentation that underlies DMAC subsystem functionality.
1.2.6.1.1.5.2 Data Dictionaries	Table 1-22	Create and maintain data dictionaries (technical documentation of data elements) used by the U.S. IOOS.
1.2.6.1.1.5.3 QA/QC Procedures	Table 1-22	Create, maintain, and modify quality assurance and quality control procedures that will be employed by U.S. IOOS participants.
1.2.6.1.1.5.4 Metadata Profiles	Table 1-22	Create and maintain metadata profiles that will be used by U.S. IOOS participants.
1.2.6.1.1.5.5 Catalogs	Table 1-22	Create standards for development and maintenance of catalogs.
1.2.6.1.2 Federal Assets	1.2.2.4.2	Currently, this DMAC function is being updated.
1.2.6.1.3 Non-Federal Assets	1.2.2.4.3	Currently, this DMAC function is being updated.
1.3. Modeling and analysis subsystem	1.2.3	Includes all data/services customers of U.S. IOOS to include Federal, regional, national, international, NGO, corporate, institutional and private citizen users. All users of U.S. IOOS receive their data/utility services through the processes defined in the Modeling and Analysis subsystem and use these processes to make their requirements known. The Customer Needs process defined in this subsystem combined with the User Councils (Governance and Management) and U.S. IOOS monitoring and assessments processes (all subsystems) are the three methods by which U.S. IOOS defines its requirements and establishes its goals.
1.3.1. Customer needs management	1.2.3.1	Capture customer needs, translate those needs into requirements, and evaluate the requirements to determine possible sources to resolve customer data needs. Includes processes to record and manage unmet requirements, determine possible solutions, and advocate with user council members to implement solutions.
1.3.1.1 Central Function	1.2.3.1.1	Addressing customer needs is a requisite central function.
1.3.1.1.1 Customer input	1.2.3.1.1	Receive customer input and determine requirements for DMAC services or feedback on U.S. IOOS procedures and policies: Survey—Obtain customer input through periodic surveys of data/services customers. Comments—Receive and adjudicate data/services customer comments received through an IOOS DMAC-compliant data/utility service or help desk calls. Requests—Receive and adjudicate specific data/services customer requests.
1.3.1.1.2 Data needs assessment	1.2.3.1.1	Assess whether data/services customer needs can be met with existing data sources: Determine Needs—Interpret data/services customer requirements in terms of data/services required. Determine Sources—Align data requirements with existing U.S. IOOS and non-U.S. IOOS data/services sources. Negotiate Participation—Negotiate with non-U.S. IOOS data/services providers to participate in U.S. IOOS and make available the required data/service.

Table 7.2-1. Work Breakdown Dictionary showing definition of functional areas by WBS identifier and functional responsibility.

Appendix C WBS	CARD System Config. Supporting Paragraph Reference	Definition
1.3.1.1.3 Model output needs assessment	1.2.3.1.1	Assess whether data/services customer needs can be met with existing model outputs. Determine Needs—Interpret data/services customer requirements in terms of model output products. Determine Sources—Align requirements with existing U.S. IOOS and non-U.S. IOOS model output sources. Negotiate Participation—Negotiate with non-U.S. IOOS model output sources to participate in U.S. IOOS and make available the required data.
1.3.1.1.4 Service needs assessment	1.2.3.1.1	Assess whether data/services customer needs can be met with existing, new, or modified DMAC services: Determine Needs—Interpret data/services customer requirements in terms of DMAC services. Determine Service—Align data/services customer requirements with existing DMAC services or to recommend new or modified services for development.
1.3.1.1.5 Unfulfilled requirements management	1.2.3.1.1	Manage data/services customer requirements that could not be satisfied by existing data providers (U.S. IOOS or non-U.S. IOOS), existing model outputs (U.S. IOOS and non-U.S. IOOS) or DMAC services (existing, modified, or planned): Master List Maintenance—Maintain a prioritized record of all unsatisfied data/services customer requirements. Solution Scenario Generation—Craft solution sets that meet multiple unfulfilled requirements with an emphasis on cost effectiveness, asset optimization, and efficiency. Advocacy—Shop solution scenarios to potential providers in and out of the user groups to garner consensus to make the investments necessary to implement solutions.
1.3.1.1.6 Customer help desk	1.2.3.1.1	Provide customers with help resolving questions and issues: Help Desk—Provide electronic and phone-based help to assist data/services customers in meeting their U.S. IOOS needs. Frequency Analysis—Track help requests to inform future U.S. IOOS design and funding decisions.
1.3.1.2 Federal Assets	1.2.3.1.2	The degree to which the federal assets participate in this function should be described here.
1.3.1.3 Non-Federal Assets	1.2.3.1.3	RAs are actively gathering user needs on an annual or continuing basis, and this user input is shaping their modeling and analysis research. Examples of this involvement are described here: PacIOOS is involved, through regular stakeholder engagement, in the assessment of customer needs for data collection, model, and product development. These annual needs assessments and reviews are used to refine proposals for future activities and annual drawdowns in proposed operations. AOOS conducts user and customer surveys, stakeholder workshops and direct stakeholder meetings to determine user needs. NANOOS works with its users to understand needs and provide outreach and engagement. SECOORA partners with stakeholders at workshops, annual meetings, and through the engagement of the south Atlantic Alliance. SECOORA has also conducted stakeholder assessments and reviewed other assessments for applicability in establishing priorities.

Table 7.2-1. Work Breakdown Dictionary showing definition of functional areas by WBS identifier and functional responsibility.

Appendix C WBS	CARD System Config. Supporting Paragraph Reference	Definition
1.3.2. IOOS sponsored and other model management	1.2.3.2	Assess models and make their outputs available through U.S. IOOS. Once the decision is made to provide a models output through U.S. IOOS, the processes used are identical to those used to bring a new data providers into U.S. IOOS.140
1.3.3. Partner agreements management (MOUs)	1.2.3.3	Govern the management of memorandums of understanding between U.S. IOOS and potential data providers/sponsored models owners. These MOUs articulate the required steps to become certified and registered as a U.S. IOOS provider, expected functionality consistent with U.S. IOOS participatory role and define the expected schedule for those actions.
1.3.3.1 Central Function	1.2.3.3.1	MOU management is a requisite central function. This function contains the following sub activities. Create MOU Create MOUs. Gain concurrence Approve MOUs. Coordinate for certification Transition a potential data/service provider DAC/sponsored model output from MOU status to certification as a U.S. IOOS data provider
1.3.3.2 Federal Function	1.2.3.3.2	The degree to which the federal assets participate in this function should be described here.
1.3.3.3 Non-Federal Function	1.2.3.3.3	No non-federal assets are associated with this function.
1.3.4. Publishing IOOS Standards	1.2.3.4	Make U.S. IOOS standards accessible to data/services customers.
1.3.4.1 Central Function	1.2.3.4.1	Publication of standards is a requisite central function.
1.3.4.1.1 Standards to use	1.2.3.4.1	Disseminate existing standards information.
1.3.4.1.2 How to's/manuals	1.2.3.4.1	Make available simple “how to” instructions for using U.S. IOOS data and services.
1.3.4.1.3 Reference Implementations	1.2.3.4.1	Develop, maintain, and make available reference implementations for typical customer needs.
1.3.4.2 Federal Function	1.2.3.4.2	Federal participants are assisting in the promulgation of U.S. IOOS standards, in concert with the U.S. IOOS Program Office.
1.3.4.3 Non-Federal Function	1.2.3.4.3	RAs are assisting in the promulgation of U.S. IOOS standards in collaboration with the U.S. IOOS Program Office and federal partners.
1.4. Governance and management subsystem	1.2.4	As described in the U.S. IOOS Blueprint, the governance and management subsystem will this function will support U.S. IOOS in terms of guidance, resources, process, tools, and infrastructure.
1.4.1. User group feedback mechanisms	1.2.4.1	As described in the U.S. IOOS Blueprint, this function will provide input/feedback on plans for and execution of the U.S. IOOS. It will provide a forum for discussion of U.S. IOOS user needs keyed to specific areas of interest and to influence future U.S. IOOS plans. I will also provide a forum through which collaboration and agreements for future development can be made. These mechanisms are a primary conduit for U.S. IOOS to stay engaged with myriad System stakeholders. They are advisory in nature, but also provide a forum in which agreements between partners can be initiated and IOOS plans can be vetted
1.4.1.1 Central Function	1.2.4.1.1	User councils constitute a requisite central function. This function is broken into the following sub activities. *Source: U.S. Integrated Ocean Observing System: A Blueprint for Full Capability, pp. F-1, F-2.*

Table 7.2-1. Work Breakdown Dictionary showing definition of functional areas by WBS identifier and functional responsibility.

Appendix C WBS	CARD System Config. Supporting Paragraph Reference	Definition
1.4.1.1.1 Standards bodies	Table 1-32	Represent the interests of the various standards organizations that govern nationally and international recognized standards used by U.S. IOOS (OGC, ISO, etc.).
1.4.1.1.2 Data providers	Table 1-32	Represents data providers who are current or anticipated U.S IOOS compliant data providers. These data providers include DAC owners, owners of U.S. IOOS sponsored models, and archives.
1.4.1.1.3 Data/service customers	Table 1-32	Represents the various U.S. IOOS customer communities. These include customers that access data directly from the source (DACs, archives, or sponsored models) and those that use U.S. IOOS-compliant data or utility services. There may be subgroups within this user council to represent the various types of customers such as high-volume institutional users or low-volume users such as citizens. Third-party service providers are included in this user group.
1.4.1.1.4 Federal partners	Table 1-32	Represents the interests of federal agencies that have a role or interest in ocean observing data.
1.4.1.1.5 RAs	Table 1-32	Represents the interests of the RAs participating in, or anticipated to participate in, U.S. IOOS.
1.4.1.1.6 NGOs	Table 1-32	Represents the interests of non-governmental entities not represented in other user councils (i.e., they are not federal entities and they are not part of the U.S. IOOS regional structure). The Consortium on Ocean Leadership is an example of an NGO.
1.4.1.1.7 International	Table 1-32	Represents the interests of integrating U.S. IOOS with international ocean observations. This includes GEOSS and GOOS: GEOSS—Represents the interests of integrating U.S. IOOS into GEOSS. GOOS—Represents the interests of integrating U.S. IOOS into GOOS.
1.4.1.1.8 IEOS	Table 1-32	Represents the interests of integrating U.S. IOOS into IEOS.
1.4.1.1.9 Combined forums by geographic area	Table 1-32	Represents all U.S. IOOS users with a role or interest in a stated large geographic area (e.g., the Atlantic Ocean). Council members may include data collectors that collect ocean observing data in that area, data providers that assemble observations and make them available in DMAC-compliant form for that area, Federal agencies, RAs, international members, data/services customers, and others.
1.4.1.1.10 Combined forums by functional area	Table 1-32	Represents all U.S. IOOS users with a role or interest in a stated functional area of interest (e.g., ocean acidification). Council members may include data collectors that collect relevant ocean observing data, data providers that compile relevant observations, federal agencies, RAs, international members, data/services customers, and others.
1.4.1.1.11 R&D asset owners	Table 1-32	Represents the interests of U.S. IOOS participating organizations that conduct R&D. This forum allows for an exchange of ideas about approaches to solving ocean observation problems, coordination across R&D programs, transition from R&D to operations, and joint R&D ventures and budgeting.
1.4.1.2 Federal Assets	1.2.4.1.2	Federal agencies also have user councils. For instance, NMFS has regional fishery councils.
1.4.1.3 Non-Federal Assets	1.2.4.1.3	RAs provide a conduit for U.S. IOOS to and from end user communities of varying interests. Each RA can be thought of as the core of a regionally focused user council. NFRA itself is also a user council.

Table 7.2-1. Work Breakdown Dictionary showing definition of functional areas by WBS identifier and functional responsibility.

Appendix C WBS	CARD System Config. Supporting Paragraph Reference	Definition
1.4.2. Financial Management	1.2.4.2	As described in the U.S. IOOS Blueprint, this function will manage planning, programming, budgeting, and expenditure of funds. This includes management of internal U.S. IOOS Program funds, funding for U.S. IOOS projects, and coordination of financial plans and budgets with other U.S. IOOS participating organizations.
1.4.2.1 Central Function	1.2.4.2.1	Financial management is a requisite central function. This function is broken into the following sub activities. *Source: U.S. Integrated Ocean Observing System: A Blueprint for Full Capability, p. F-2.*
1.4.2.1.1 Financial plans	Table 1-33	Create U.S. IOOS financial plans, including prescribed planning, programming, and budget documents.
1.4.2.1.2 Budget	Table 1-33	Create U.S. IOOS-required planning, programming, and budget documentation and to develop final budget plans.
1.4.2.1.3 Execution	Table 1-33	Manage execution of the annual budget.
1.4.2.1.4 Analysis	Table 1-33	Conduct program/budget analysis, economic analysis, and cost benefit studies.
1.4.2.1.5 Interagency coordination	Table 1-33	Create financial plans and monitor execution of funds in cooperation with other federal and non-federal U.S. IOOS organizations.
1.4.2.2 Federal Assets	1.2.4.2.2	Federal partners perform this level of management for the assets under their purview.
1.4.2.3 Non-Federal Assets	1.2.4.2.3	RAs perform this level of management for the assets under their purview.
1.4.3. Policy	1.2.4.3	As described in the U.S. IOOS Blueprint, this function will create and manage internal and external policy of the U.S. IOOS Program. Policies may be administrative, such as the steps required to become a data provider, or technical, such as data quality standards that must be in place. Congressional liaison activities fall within this area.
1.4.3.1 Central Function	1.2.4.3.1	Policy is a requisite central function. This function is broken into the following sub activities. *Source: U.S. Integrated Ocean Observing System: A Blueprint for Full Capability, p. F-2.*
1.4.3.1.1 Intramural	Table 1-34	Create and manage policy within the U.S. IOOS Office.
1.4.3.1.2 Extramural	Table 1-34	Create and manage policies that affect external partners. These include technical and administrative: Technical—Create and manage technical policy. Administrative—Create and manage administrative policy.
1.4.3.1.3 Congressional liaison	Table 1-34	Provide information requested by congressional members and analyze congressional language to assess policy ramifications.
1.4.3.2 Federal Assets	1.2.4.3.2	No federal assets are associated with this function.
1.4.3.3 Non-Federal Assets	1.2.4.3.3	No non-federal assets are associated with this function.

Table 7.2-1. Work Breakdown Dictionary showing definition of functional areas by WBS identifier and functional responsibility.

Appendix C WBS	CARD System Config. Supporting Paragraph Reference	Definition
1.4.4. Plans and Operations	1.2.4.4	As described in the U.S. IOOS Blueprint, this function will manage plans and operations supporting the full range of U.S. IOOS activities. These include coordination of IOOS subsystem development efforts, plans and operations relating to modeling and analysis, DMAC observing subsystem, R&D, training and education, and change management. (In addition to routine functions of planning and controlling U.S. IOOS functions, plans and operations can include activities agreed upon by user council, national, or international plans agreed to by U.S. IOOS.)
1.4.4.1 Central Function	1.2.4.4.1	Plans and operations constitute a requisite central function. This function is broken into the following sub activities. *Source: U.S. Integrated Ocean Observing System: A Blueprint for Full Capability, pp. F-3–F-4.*
1.4.4.1.1 Plans	Table 1-35	Create and manage plans that coordinate activities at a national level.
1.4.4.1.1.1 National	Table 1-35	Create and manage plans that coordinate activities at a national level that may include members of some or all user councils or other entities with interest. (Examples are the National Waves Plan and the National Surface Current Mapping Plan.)
1.4.4.1.1.2 IOOS Internal	Table 1-35	Create and manage plans that do not include participation by non-U.S. IOOS partners. Requires the following lower-level sub activities: Observations—Create and manage plans, including regional U.S. IOOS plans, relating to development, management, and improvement of ocean observing capability. Data Providers—Create and manage plans relating to management of U.S. IOOS data providers, include federal and non-federal data assembly centers, sponsored models, and archives. DMAC Services—Create and manage plans that affect DMAC services development, management, evolution, and delivery. Models—Create and manage plans that affect data delivery to models and efforts to assimilate and manage U.S. IOOS-sponsored models. Archives—Create and manage plans that affect U.S. IOOS-compliant archives, including data storage, retrieval, and backup. Education—Create and manage plans related to assessing U.S. IOOS related training and education requirements, content development, and delivery. R & D—Create and manage plans related to R&D efforts in support of U.S. IOOS or user council member needs.
1.4.4.1.1.3 International	Table 1-35	Create and manage plans that coordinate activities at an international level that may include members of some or all user councils or other entities with an interest in the plan (e.g., U.S. participation in an international ocean observing plan).
1.4.4.1.2 Operations	Table 1-35	Control, monitor, and report on operations covering the full range of U.S. IOOS activities. These include operations relating to modeling and analysis, DMAC, observing subsystem, R&D, and training and education. Operations can include activities agreed upon by user councils and national or international plans agreed to by U.S. IOOS. Operations are conducted at the interagency, national, international, regional assessment, regional project, and program office levels.

Table 7.2-1. Work Breakdown Dictionary showing definition of functional areas by WBS identifier and functional responsibility.

Appendix C WBS	CARD System Config. Supporting Paragraph Reference	Definition
1.4.4.1.2.1 Interagency	Table 1-35	Control, monitor, and report on operations conducted with or by interagency partners. Program Management Teams—Manage interagency programs and projects where U.S. IOOS is the lead.
1.4.4.1.2.2 National	Table 1-35	Control, monitor, and report on operations conducted with or by domestic partners.
1.4.4.1.2.3 International	Table 1-35	Control, monitor, and report on operations conducted with or by international partners. Program Management Teams—Manage international programs and projects where U.S. IOOS represents the United States as the lead country.
1.4.4.1.2.4 Regional Assessment	Table 1-35	Conduct capability maturity assessments of the U.S. IOOS regions.
1.4.4.1.2.5 Regional Project Management	Table 1-35	Manage regional projects funded by U.S. IOOS.
1.4.4.1.2.6 Program Office Internal	Table 1-35	Control, monitor, and report on U.S. IOOS Program Office internal operations.
1.4.4.2 Federal Assets	1.2.4.4.2	No federal assets are associated with this function.
1.4.4.3 Non-Federal Assets	1.2.4.4.3	Non-federal partners and RAs provide these management sub-activities within their own associations.
1.4.5. Processes	N/A	Processes are maintained within each WBS element and not separated in this element.
1.4.6. Human resources management	1.2.4.5	As described in the U.S. IOOS Blueprint, this function will manage/coordinate U.S. IOOS Program Office human resources, including job descriptions, hiring, employee benefits, personnel actions, and other routine personnel administration tasks.
1.4.6.1 Central Function	1.2.4.5.1	Human resources constitute a requisite central function. This function is broken into the following sub activities. *Source: U.S. Integrated Ocean Observing System: A Blueprint for Full Capability, p. F-4.*
1.4.6.1.1 Staffing	Table 1-36	Manage people to positions.
1.4.6.1.2 Recruiting	Table 1-36	Recruit new employees.
1.4.6.1.3 Awards	Table 1-36	Receive recommendations and approve awards.
1.4.6.1.4 Personnel actions	Table 1-36	Perform personnel actions.
1.4.6.1.5 Training	Table 1-36	Manage training for employees.
1.4.6.1.6 Benefits	Table 1-36	Manage employee benefit programs.
1.4.6.1.7 Personnel records	Table 1-36	Maintain and update employee personnel files.
1.4.6.1.8 Personnel policy	Table 1-36	Develop and implement personnel policies.
1.4.6.2 Federal Assets	1.2.4.5.2	Federal partners perform this level of management for the assets under their purview.
1.4.6.3 Non-Federal Assets	1.2.4.5.3	Non-federal partners and RAs provide these management sub-activities within their own associations.

Table 7.2-1. Work Breakdown Dictionary showing definition of functional areas by WBS identifier and functional responsibility.

Appendix C WBS	CARD System Config. Supporting Paragraph Reference	Definition
1.4.7. Acquisition and Grants	1.2.4.6	As described in the U.S. IOOS Blueprint, this function will acquire required items and services, award grants and cooperative agreements, and conduct independent cost estimates.
1.4.7.1 Central Function	1.2.4.6.1	Acquisition and grants constitute a requisite central function. This function is broken into the following sub activities. *Source: U.S. Integrated Ocean Observing System: A Blueprint for Full Capability, p. F-4.*
1.4.7.1.1 Purchasing	Table 1-37	Make purchases (including government credit card).
1.4.7.1.2 Contracting	Table 1-37	Manage contracts from identification of requirements through closeout.
1.4.7.1.3 Grants and cooperative agreements	Table 1-37	Create FFO, conduct competitions, award grants and cooperative agreements, and manage post-award administration: Services—Create and manage services grants and cooperative agreements. R&D—Create and manage R&D grants and cooperative agreements.
1.4.7.1.4 Independent cost estimates	Table 1-37	Conduct independent cost estimates in anticipation of a contracting action.
1.4.7.2 Federal Assets	1.2.4.6.2	Federal partners perform this level of management for the assets under their purview.
1.4.7.3 Non-Federal Assets	1.2.4.6.3	RAs are the recipients of grant actions, and also create cooperative agreements and manage purchases and contracts.
1.4.8. Marketing, Outreach and Engagement	1.2.4.7	As described in the U.S. IOOS Blueprint, this function will convince data providers, data/services customers, and model owners to participate in U.S. IOOS. This function includes “communications,” outreach, and other aspects of managing the public face of U.S. IOOS, but has a strong central focus on causing the target audience to join and actively participate in the U.S. IOOS effort. Although some activities are similar to traditional “outreach,” the purpose of outreach is to inform, while this effort is not considered successful if only information is transmitted. This is targeted information designed to engender action. It is also fundamentally different from “training and education,” where the intent is to give the target audience a skill or knowledge.
1.4.8.1 Central Function	1.2.4.7.1	Marketing, outreach, and engagement constitute a requisite central function. This function is broken into the following sub activities. *Source: U.S. Integrated Ocean Observing System: A Blueprint for Full Capability, pp. F-4–F-5.*
1.4.8.1.1 Manage communication strategy	Table 1-38	Create and manage the communication strategy, including identification of target audiences, desired outcomes, communications messages, channels, vehicles, schedules, and results assessments.
1.4.8.1.2 Create products	Table 1-38	Manage creation of marketing, outreach, and engagement products, including brochures, web pages, articles, position papers, briefings, and congressional correspondence support documents.
1.4.8.1.3 Speaker program	Table 1-38	Manage providing U.S. IOOS knowledgeable speakers at influential conferences and other venues according to the communications strategy.
1.4.8.1.4 Conference participation	Table 1-38	Ensure knowledgeable and proactive participation at U.S. IOOS related conferences.

Table 7.2-1. Work Breakdown Dictionary showing definition of functional areas by WBS identifier and functional responsibility.

Appendix C WBS	CARD System Config. Supporting Paragraph Reference	Definition
1.4.8.1.5 Membership in forums	Table 1-38	Ensure that U.S. IOOS is properly represented in councils and forums of importance to U.S. IOOS.
1.4.8.1.6 News releases	Table 1-38	Manage media engagement and information releases to press/media outlets and third-party communications managers and publishers.
1.4.8.2 Federal Assets	1.2.4.7.2	Some federal assets participate in these sub-activities; the degree to which they contribute to IOOS needs to be defined
1.4.8.3 Non-Federal Assets	1.2.4.7.3	RAs contribute to these sub-activities through direct participation. RAs are actively engaged in the outreach of their efforts and engage other data providers to include their information in the IOOS system. RAs engage user communities by hosting conferences, conducting presentations by staff members, publishing newsletters and websites, conducting meetings, and meeting one-on-one with members of the community.
1.5. Research and development subsystem	1.2.5, 9.5	As described in the U.S. IOOS Blueprint, this function will gather R&D requirements, analyze and prioritize those requirements, and publish the requirements to inform R&D efforts.
1.5.1. Requirements determination	1.2.5.1	As described in the U.S. IOOS Blueprint, this function will gather R&D requirements, analyze and prioritize those requirements, and publish the requirements to inform R&D efforts.
1.5.1.1 Central Function	1.2.5.1.1	R&D requirements determination is a requisite central function.
1.5.1.1.1 Requirements gathering	Table 1-40	Gather and record R&D requirements from all U.S. IOOS participating entities.
1.5.1.1.2 Requirements analysis	Table 1-40	Analyze raw requirements and restate them in terms meaningful to the R&D community.
1.5.1.1.3 Requirements prioritization	Table 1-40	Prioritize refined R&D requirements based on criticality and size of population that is experiencing the need.
1.5.1.1.4 Requirements publication	Table 1-40	Publish the prioritized R&D requirements to all R&D performing entities in order to spark interest and coordinate efforts.
1.5.1.2 Federal Assets	1.2.5.1.2	The gathering, evaluation, prioritization, and publication and coordination of stakeholder requirements for R&D are central functions of the federal agencies.
1.5.1.3 Non-Federal Assets	1.2.5.1.3	The gathering, evaluation, prioritization, and publication and coordination of stakeholder requirements for R&D are key functions of the RAs and RAs expending efforts performing these functions. RA principal investigators are an engine of pilot R&D projects and strive to turn pilots into sustained successful operations where appropriate.
1.5.2. Coordinate R&D programs	1.2.5.2	As described in the U.S. IOOS Blueprint, this function will coordinate research and development activities among participating U.S. IOOS R&D organizations.
1.5.2.1 Central Function	1.2.5.2.1	Coordination of R&D programs is a requisite central function.
1.5.2.1.1 Sponsor forums	Table 1-41	Sponsor forums where R&D-capable organizations can meet to discuss approaches to solving R&D requirements.
1.5.2.1.2 R&D progress monitoring	Table 1-41	Monitor and report progress in addressing R&D requirements based on R&D activities in participating organizations.

Table 7.2-1. Work Breakdown Dictionary showing definition of functional areas by WBS identifier and functional responsibility.

Appendix C WBS	CARD System Config. Supporting Paragraph Reference	Definition
1.5.2.1.3 R&D grants technical management	Table 1-41	Assess and manage R&D efforts that accrue from R&D grants made by or through U.S. IOOS.
1.5.2.1.4 R&D agreements management	Table 1-41	Create and manage cross-organizational R&D agreements to pursue solutions to prioritized R&D requirements.
1.5.2.2 Federal Assets	1.2.5.2.2	U.S. IOOS Program office and other federal partners are involved in R&D coordination for systems and are under their area of expertise.
1.5.2.3 Non-Federal Assets	1.2.5.2.3	RAs are actively involved in coordinating local research and development functions. RAs provide discussion venues for their principal investigators to share and compare research efforts. RAs include research efforts in their annual budget to carry on, promote, and sustain R&D efforts.
1.5.3. Conduct R&D programs	1.2.5.3	As described in the U.S. IOOS Blueprint, this function will create and manage R&D pilot projects that demonstrate R&D solutions to assess effectiveness and limit risk. This element is for actual implementation of R&D activities which would only apply to Federal and Non-Federal assets.
1.5.3.1 Federal Assets	1.2.5.3.2	U.S. IOOS Program office and other federal partners are involved in R&D pilot projects for systems and are under their area of expertise.
1.5.3.2 Non-Federal Assets	1.2.5.3.3	RA PIs get involved in R&D pilot projects when opportunities are present and seek to turn successful pilots into sustained operations.
1.5.4. Create a process to manage R&D pilot projects	1.2.5.3	As described in the U.S. IOOS Blueprint, this function will create and manage R&D pilot projects that demonstrate R&D solutions to assess effectiveness and limit risk.
1.5.4.1 Central Function	1.2.5.3.1	R&D pilot projects constitute a requisite central function.
1.5.4.1.1 Concept development	Table 1-42	Control development of R&D pilot project concepts, including concept approval.
1.5.4.1.2 Project team agreements	Table 1-42	Create multi-organizational R&D project teams to implement R&D pilot projects.
1.5.4.1.3 Project management	Table 1-42	Manage the R&D pilot project execution.
1.5.4.1.4 Budgeting	Table 1-42	Plan, budget, and execute financial aspects of the R&D pilot projects.
1.5.4.1.5 Reporting	Table 1-42	Assess technical merits of the R&D pilot project and report results.
1.5.5. Create a capability to conduct technology assessments	1.2.5.4	As described in the U.S. IOOS Blueprint, this function will conduct assessments of existing technology that is either in use or available for implementations from a government or commercial source. These assessments will generally be to assess the fidelity of observations and or durability and reliability of the sensor or platform.
1.5.5.1 Central Function	1.2.5.4.1	Technical assessments constitute a requisite central function.
1.5.5.1.1 Candidate technology management	Table 1-43	Maintain visibility of available technology and aspects of that technology which require assessment.
1.5.5.1.2 Technology assessment design	Table 1-43	Design technology assessments that are scientifically sound and can be conducted within budget.
1.5.5.1.3 Budget	Table 1-43	Manage the financial planning and execution of technology assessments.
1.5.5.1.4 Plans	Table 1-43	Plan and coordinate the technology assessments.
1.5.5.1.5 Operations	Table 1-43	Conduct technology assessments.

Table 7.2-1. Work Breakdown Dictionary showing definition of functional areas by WBS identifier and functional responsibility.

Appendix C WBS	CARD System Config. Supporting Paragraph Reference	Definition
1.5.5.1.6 Report generation	Table 1-43	Assess the findings of the technology assessment and create comprehensive reports on findings.
1.5.5.1.7 Findings publication	Table 1-43	Publish the findings of technology assessments to concerned parties and to make the findings generally available to all concerned U.S. IOOS participants.
1.5.5.1.8 Archive	Table 1-43	Keep permanent archives of assessment to ensure their availability for future use.
1.5.5.2 Federal Assets	1.2.5.4.2	The U.S. IOOS Program Office promotes technology assessments, particularly though funding the ACT.
1.5.5.3 Non-Federal Assets	1.2.5.4.3	RA researchers frequently evaluate new technologies through observational trials. In addition, ACT provides independent verification and validation of sensors, buoys, cables, and observing components. Some ocean observing equipment is manufactured by small technology companies and start-ups and this validation assures buyers that the observing equipment functions are designed so the market for observing equipment can function efficiently. The ACT also provides beta testing on the manufactured products back to the manufacturers.
1.5.6. Develop technology enhancements	1.2.5.5	As described in the U.S. IOOS Blueprint, this function will manage implementation of technology enhancements or upgrades to existing technology to include sensors and platforms.
1.5.6.1 Central Function	1.2.5.5.1	Technology enhancements constitute a requisite central function.
1.5.6.1.1 Project definition	Table 1-44	Define succinct projects that field specific upgrade packages to specific sets of hardware or software on a specific timeline.
1.5.6.1.2 Project management	Table 1-44	Manage the execution of planned technology enhancements.
1.5.6.1.3 Agreements management	Table 1-44	Create and manage cross-agency/organization agreements to allow execution of the planned technology enhancements.
1.5.6.1.4 Budgeting	Table 1-44	Manage the planning and execution of funds associated with fielding technology enhancements.
1.5.6.1.5 COTR	Table 1-44	Manage contractors, as necessary, that execute fielding of technology enhancements.
1.5.6.1.6 Test and evaluation	Table 1-44	Test and evaluate that enhancements are properly applied and the resulting improved technology performs to expected standards.
1.5.6.2 Federal Assets	1.2.5.5.2	The U.S. IOOS Program Office promotes technology assessments, particularly though funding the ACT.
1.5.6.3 Non-Federal Assets	1.2.5.5.3	RA researchers frequently evaluate new technologies through observational trials. ACT assists in technology enhancements by testing technologies and providing advisories to manufacturers.
1.5.7. Manage transition of technology from R&D to operational use	1.2.5.6	As described in the U.S. IOOS Blueprint, this function will assist with transitioning new R&D products from the labs to use in the field. In some cases, the R&D product will be an enhancement to an existing technology that will be executed using the processes defined for “technology enhancements.” The processes described here in “Technology Transition” will normally apply to fielding new technology solutions that may include new hardware, software, procedures, maintenance procedures, etc.

Table 7.2-1. Work Breakdown Dictionary showing definition of functional areas by WBS identifier and functional responsibility.

Appendix C WBS	CARD System Config. Supporting Paragraph Reference	Definition
1.5.7.1 Central Function	1.2.5.6.1	Technology transition is a requisite central function.
1.5.7.1.1 Project definition	Table 1-45	Establish comprehensive projects to field new technology to specific customers on a specific timeline to include training.
1.5.7.1.2 Project management	Table 1-45	Manage the execution of planned technology transitions.
1.5.7.1.3 Agreements management	Table 1-45	Create and manage cross agency/organization agreements to allow execution of the planned technology transition.
1.5.7.1.4 Budgeting	Table 1-45	Manage the planning and execution of funds associated with technology transition.
1.5.7.1.5 Test and evaluation	Table 1-45	Test and evaluate that the technology transitions are properly implemented and the resulting technology performs to expected standards.
1.6. Training and Education Subsystem	1.2.6, 2.5, 9.6	As described in the U.S. IOOS Blueprint, the training and education subsystem will manage development of U.S. IOOS specific training and educational materials to support the needs of training and education providers. These processes include development of training and education strategy, plans, and curriculum. Other processes include development and execution of training and education pilot projects, assessments and professional certifications. Training for the maintenance of observing assets is a part of researcher time that could otherwise be spent on data analysis. At full operational capability, third-party maintenance may be assumed for the observing assets. The current state of IOOS does not contain training and education facilities except those operated by contributing members of IOOS. The number and percentage of IOOS training events currently operated is unknown. Such training events should be enumerated and a description of the training venues provided, such as type of location, number of persons trained in the facility, length of training session, and frequency. The description of the training venue is most important and can be seaside, on a moving platform, in a university classroom, or an office meeting room.
1.6.1. Develop training strategy and plans	1.2.6.1	As described in the U.S. IOOS Blueprint, this function will develop U.S. IOOS training and education strategies and plans to achieve training and education strategic goals.
1.6.1.1 Central Function	1.2.6.1.1	Training and education strategy and plans development is a requisite central function. This function is broken into the following sub activities. *Source: U.S. Integrated Ocean Observing System: A Blueprint for Full Capability, p. F-20.*
1.6.1.1.1 Strategy development	Table 1-46	Manage development of U.S. IOOS training and education strategy.
1.6.1.1.2 Plans development	Table 1-46	Manage development of U.S. IOOS training and education plans.
1.6.1.2 Federal Assets	1.2.6.1.2	The U.S. IOOS Program Office promotes development of training and education through its regional and federal partners.

Table 7.2-1. Work Breakdown Dictionary showing definition of functional areas by WBS identifier and functional responsibility.

Appendix C WBS	CARD System Config. Supporting Paragraph Reference	Definition
1.6.1.3 Non-Federal Assets	1.2.6.1.3	RAs, including AOOS, provide lead PIs for COSEE regional offices. COSEE is a NSF funded program for ocean education, and uses the observing system as a component of teacher workshops and other education programs. Additionally RAs coordinate training and education in their regions to the extent that their resources allow. SECORRA has an Education and Outreach committee that defines and coordinates its projects for the RA.
1.6.2. Develop training and curriculum	1.2.6.2	As described in the U.S. IOOS Blueprint, this function will manage development of U.S. IOOS training programs and curriculum.
1.6.2.1 Central Function	1.2.6.2.1	Training and curriculum development is a requisite central function. This function is broken into the following sub activities. *Source: U.S. Integrated Ocean Observing System: A Blueprint for Full Capability, p. F-20.*
Training development	Table 1-47	Develop training programs to meet the needs of U.S. IOOS members (organizations and individuals).
Curriculum development	Table 1-47	Develop curriculum to meet the educational needs of U.S. IOOS members (organizations and individuals).
1.6.2.2 Federal Assets	1.2.6.2.2	No federal assets are associated with this function.

Table 7.2-1. Work Breakdown Dictionary showing definition of functional areas by WBS identifier and functional responsibility.

Appendix C WBS	CARD System Config. Supporting Paragraph Reference	Definition
1.6.2.3 Non-Federal Assets	1.2.6.2.3	The Centers for Ocean Sciences Education Excellence (COSEE) Network has established 12 thematic and regional Centers located around the U.S. The overall mission is "to spark and nurture collaborations among research scientists and educators to advance ocean discovery and make known the vital role of the ocean in our lives." COSEE goals include integrating ocean research into high-quality educational materials; enabling ocean researchers to better understand educational organizations and pedagogy; and enhancing high-quality educational programs in the ocean sciences. AOOS and other RAs work with COSEE curriculum development to incorporate ocean observing. Many RAs PIS develop training and education. For example, PacIOOS is involved, directly, in both curriculum development and training. COSEE personnel, through PacIOOS support, have taught professional and introductory level GIS classes in Hawaii and the Marshall Islands. These classes are taught annually in one or more PacIOOS sub-regions. Also, PacIOOS has been directly involved in the development of ocean science curriculum in Hawaii through the Navigating Change Curriculum Program. The Navigating Change Curriculum Program combines scientific, cultural, and stewardship principles into a hands-on curriculum that aims at encouraging students to be proactive about caring for the land and sea in their neighborhoods (aka "navigating change in their communities"). The program coordinator felt that an important addition to the curriculum was a unit addressing climate change. PacIOOS created a climate change unit that addresses two topics: 1) sea level rise, and 2) ocean temperature and coral health. All materials are available on a teacher resource CD which includes two in-class lessons and accompanying hands-on activities, handouts, instructional video, and informational video on global ocean observing. SECOORA will partner with the Monterey Bay Research Institute to offer a 2012 Education and Research, Testing Hypotheses (EARTH) workshop. EARTH has a strong history of delivering inquiry lessons based on ocean observing systems and real-time data. The workshop will deliver lesson plans based on data from SECOORA assets, aligned with national science standards, and posted on both the EARTH and SECOORA websites. SECOORA also supports the development of additional teacher materials.
1.6.3. Conduct training and education pilot projects	1.2.6.3	As described in the U.S. IOOS Blueprint, this function will develop and execute U.S. IOOS specific training and education pilot projects.
1.6.3.1 Central Function	1.2.6.3.1	Training and education pilot projects constitute a requisite central function. This function is broken into the following sub activities. *Source: U.S. Integrated Ocean Observing System: A Blueprint for Full Capability, p. F-20.*
1.6.3.1.1 Concept development	Table 1-48	Manage the development of training and education pilot project concepts.
1.6.3.1.2 Project team agreements	Table 1-48	Secure agreements with participating organizations to conduct the training and education pilot project.
1.6.3.1.3 Project management	Table 1-48	Manage the conduct of training and education pilot projects.

Table 7.2-1. Work Breakdown Dictionary showing definition of functional areas by WBS identifier and functional responsibility.

Appendix C WBS	CARD System Config. Supporting Paragraph Reference	Definition
1.6.3.1.4 Budgeting	Table 1-48	Manage the financial planning and execution of training and education pilot projects.
1.6.3.1.5 Reporting	Table 1-48	Manage reporting results from training and education pilot projects.
1.6.3.2 Federal Assets	1.2.6.3.2	No federal assets are associated with this function.
1.6.3.3 Non-Federal Assets	1.2.6.3.3	RAs support and participate in training and education pilot projects as budgets and opportunity allow. For example, SECOORA has been working with COSEE-SE and NOAA IOOS on the Basic Observation Buoy (BOB) project. BOB is a low cost student-constructible floating platform with capacity to carry a suite of environmental sensors.
1.6.4. Conduct assessments of training and education	1.2.6.4	As described in the U.S. IOOS Blueprint, this function will create, execute, and assess the results of U.S. IOOS training and education programs. These assessments may take the form of standard tests that accompany training packages and curriculum, or they may be assessments of effectiveness of training programs and curriculum. Assessments include the creation, executing, and evaluation of certification testing for U.S. IOOS professional certifications.
1.6.4.1 Central Function	1.2.6.4.1	Training and education assessments constitute a requisite central function. This function is broken into the following sub activities. *Source: U.S. Integrated Ocean Observing System: A Blueprint for Full Capability, p. F-20.*
1.6.4.1.1 Work force needs assessments	N/A	Create, execute and assess the training and education needs of U.S. IOOS workforce. This includes U.S. IOOS Program Office personnel as well as data providers, archives, sponsored model owners, and data/services customers.
1.6.4.1.2 Assessment development	N/A	Develop assessments tools to support training programs and curriculum products to include professional certifications.
1.6.4.1.3 Assessment results and evaluation	N/A	Evaluate the results of administered assessments and determine effectiveness of training and education efforts and to provide feedback to improve future training and education products.
1.6.4.2 Federal Assets	1.2.6.4.2	No federal assets are associated with this function.
1.6.4.3 Non-Federal Assets	1.2.6.4.3	No non-federal assets are associated with this function.
1.6.5. Conduct training requirements assessments	1.2.6.4	As described in the U.S. IOOS Blueprint, this function will create, execute, and assess the results of U.S. IOOS training and education programs. These assessments may take the form of standard tests that accompany training packages and curriculum, or they may be assessments of effectiveness of training programs and curriculum. Assessments include the creation, executing, and evaluation of certification testing for U.S. IOOS professional certifications.
1.6.5.1 Central Function	Table 1-49	Training and education assessments constitute a requisite central function that decomposes into the following subactivities.
1.6.5.1.1 Work force needs assessments	Table 1-49	Create, execute and assess the training and education needs of U.S. IOOS workforce. This includes U.S. IOOS Program Office personnel as well as data providers, archives, sponsored model owners, and data/services customers.

Table 7.2-1. Work Breakdown Dictionary showing definition of functional areas by WBS identifier and functional responsibility.

Appendix C WBS	CARD System Config. Supporting Paragraph Reference	Definition
1.6.5.1.2 Assessment development	Table 1-49	Develop assessments tools to support training programs and curriculum products to include professional certifications.
1.6.5.1.3 Assessment results and evaluation	Table 1-49	Evaluate the results of administered assessments and determine effectiveness of training and education efforts and to provide feedback to improve future training and education products.
1.6.5.2 Federal assets	1.2.6.4.2	No federal assets are associated with this function.
1.6.5.3 Non-federal assets	1.2.6.4.3	No non-federal assets are associated with this function.
1.6.6. Collaborate with education delivery managers	1.2.6.5	As described in the U.S. IOOS Blueprint, this function will manage relationships with entities that deliver educational services and deliver U.S. IOOS-related training or education. U.S. IOOS will not own classrooms or instructors, but will provide training programs and curriculum for others to use. This requires robust collaboration to ensure that training and education requirements are well understood and to ensure that training and education products are properly used.
1.6.6.1 Central Function	1.2.6.5.1	This requisite central function has not been decomposed into sub-activities.
1.6.6.2 Federal Assets	1.2.6.5.2	The degree to which the federal assets participate in this function should be described here, specifically the plans and actions supporting the provision of education products.
1.6.6.3 Non-Federal Assets	1.2.6.5.3	Many primary investigators that participate in the RAs are university professors who provide training and education. RAs are also engaged in research and education collaboration through local partners such as COSEE. As a partner of COSEE AK, AOOS works closely with rural school districts and their curriculum developers. SECOORA coordinates with educators in the BOB project and EARTH Workshops. COSEE-SE and COSEE-FL are members of SECOORA. Numerous other partnerships exist.
1.6.7. Manage professional certifications	1.2.6.6	As described in the U.S. IOOS Blueprint, this function will create and manage U.S. IOOS professional certifications, as required. These certifications may be related to any of the U.S. IOOS subsystems. Examples may include IT certifications at the data provider/archive level related to proper integration of U.S. IOOS data services or certifications to manage U.S. IOOS test and evaluation projects.
1.6.7.1 Central Function	1.2.6.6.1	Professional certifications constitute a requisite central function. This function is broken into the following sub activities. *Source: U.S. Integrated Ocean Observing System: A Blueprint for Full Capability, p. F-21.*
Standards development	Table 1-50	Develop the standards for certifications.
Publications	Table 1-50	Publish and maintain the certification standards.
Assessment administration	Table 1-50	Perform assessments of an individual's ability to meet certification standards.
Application processing	Table 1-50	Receive and adjudicate request for certification packets.
Certification and notifications	Table 1-50	Award certification and make notifications.
Records maintenance	Table 1-50	Maintain records of certifications so that concerned parties can easily access them
1.6.7.2 Federal Assets	1.2.6.6.2	No federal assets are associated with this function.

Table 7.2-1. Work Breakdown Dictionary showing definition of functional areas by WBS identifier and functional responsibility.

Appendix C WBS	CARD System Config. Supporting Paragraph Reference	Definition
1.6.7.3 Non-Federal Assets	1.2.6.6.3	No non-federal assets are associated with this function.
1.6.8. Conduct training and education activities	N/A	Definition not available in CARD
1.6.9. Develop educational audience	N/A	Definition not available in CARD
1.6.10. Create a workforce to staff the audience	N/A	Definition not available in CARD
2. Operations and Sustainment	N/A	
2.1. Systems engineering and program management	N/A	The technical and management efforts of directing and controlling an integrated engineering effort for the project.
2.2. System operations [replication of 1.X functions in sustain mode]	N/A	Replication of 1.X functions in sustaining mode. Operational aspects of WBS 1.0.
2.3. Maintenance	N/A	Maintain current assets thru repairs and HW/SW replacement/refresh.
2.4. Sustaining support/engineering	N/A	Respond to changes in operating environment and accommodate future growth, does not include new functionality or improvements.
2.5. Indirect continuing support	N/A	Maintain a workforce pipeline, support training and education, and support follow on user training.
2.6. Continuing system improvements	N/A	Improvements and new development to the operational system after initial system deployment.

7.3 BIO/RESUME OF TEAM

7.3.1 Richard B. Bennett

ICE Task Manager
Jet Propulsion Laboratory
Engineering and Science Directorate

Mr. Bennett is a Project System Engineer and Manager for JPL providing system engineering, technical leadership, and contract technical management to formulation, development, and flight missions. His experience, spanning over 30 years, has included both line and project management positions. He has served in industry as the Operations Manager for the production flow development and launch of the first of a new product line of three-axis stabilized communications satellites (HS-601), AUSSAT B1 & B2 (subsequently known as Optus B1 & B2). He held positions of Section and Assistant Department Manager of 80 scientists, engineers and technicians involved in the design and development of satellite, deep space, and Space Shuttle avionic control electronics. Other JPL/NASA project responsibilities have included Project System Engineering Lead for NASA's Discovery 4 – Genesis Mission, Deputy Observatory Engineer & Flight Director for Spitzer, a NASA Space Infrared Telescope Mission, and Flight System Contract Technical Manager for NASA's Discovery 10 – Kepler Mission.

7.3.2 Milana K. Wood

ICE Team Cost Lead
Jet Propulsion Laboratory
Section 251, Cost Estimating and Pricing Section, Program Business Management Division

Milana Wood is a senior cost engineer in the Cost Estimation and Pricing Section and has over 10 years of JPL/NASA experience in cost estimating and analysis; Independent Cost Estimates, parametric cost estimating, process improvement, program business management, cost research, and risk analysis. She has led the development of numerous Independent Cost Estimates within JPL and NASA, most recently SMAP, Jason 3, and the Europa Habitability Mission. Mrs. Wood received her B.S, in Information Systems, Magna cum Laude, from California State University, Northridge and an M.B.A from the Marshall School of Business at University of Southern California.

7.3.3 Michael J. Fong

ICE Cost Engineer
Jet Propulsion Laboratory
Cost Estimating and Pricing Section, Program Business Management Division

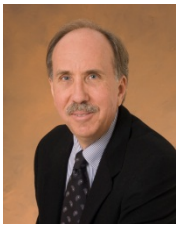
Michael Fong is a Senior Cost Engineer at NASA's JPL with over 20 years of experience in systems engineering and cost analysis for major defense systems and planetary exploration missions. As a systems engineer, he supported the thermal vacuum testing of the TDRSS communications payload and was responsible for I&T of the digital processor units on the Milstar communications satellite. His career in cost analysis includes model development, cost research, cost estimating, and conducting trade studies for both the DoD while working for Tecolote Research, Inc. and currently at NASA with JPL. At JPL, Mr. Fong has provided cost support to several radar concepts including ECHO, InSAR, SMAP, and DESDynI. He was also a key contributor in the development of JPL's first CARD for the Mars Reconnaissance Orbiter and continues to lead or consult on the production of NASA CADRe documents for several other JPL missions.

7.3.4 Cate Heneghan

ICE System Engineer
Jet Propulsion Laboratory
Engineering and Science Directorate

Cate Heneghan is the System Engineer for the IOOS ICE task at JPL. She is also currently system engineer on an airborne science mission, facilitator for JPL's concurrent engineering design team, and manager for a Titan chemistry research project. When not working these tasks, she typically performs system engineering and proposal management during the mission concept development phase on astrophysics and earth science missions. Ms. Heneghan began her career at JPL by analyzing extravehicular activities on the International Space Station. Other responsibilities have included requirements development for several projects, management of the development and implementation of a web-based management information system and project planning and control. Ms. Heneghan has been awarded over three dozen awards from NASA, JPL and AIAA including two NASA Technical Briefs and a JPL Award for Excellence. She has an M.S. in Astronautic Engineering from USC.

7.3.5 Douglas Hughes



ICE DMAC System Engineer
Jet Propulsion Laboratory
OCIO, Computing and Networking Division

Douglas Hughes is an IT Project Manager in the JPL Office of the Chief Information Officer (OCIO) Computing and Networking Division and is responsible for Hosting (application, database and storage), Cloud Provisioning and the Remote Data Center. Mr. Hughes also provides system engineering and infrastructure services to NASA and DoD customers. Mr. Hughes began his career at JPL working on a classified, software-intensive DoD project and transitioned to s series of projects including a very large-scale, multiple-entity, simulation and an earth-observing, SAR satellite ground data system for an EOS DAAC. Direct NASA responsibilities have included system engineering and infrastructure implementation for the initial release of the completely redesigned NASA Portal (www.nasa.gov) in 2002-2003, hosting and web-related services consultation to the NASA I3P WEST procurement evaluation team, and system engineering and technical consultation on the Independent Review Team (IRT) for the Enterprise Service Desk (ESD). Recent DoD-related experience has included system engineering and technical consulting to the Knowledge Management Program at the U.S. Air Force Space and Missile Systems Center (SMC).

7.3.6 Troy J. Schmidt

ICE Cost Engineer
Jet Propulsion Laboratory
Section 251, Cost Estimating and Pricing Section, Program Business Management Division

Troy Schmidt is a senior cost engineer in the Cost Estimation and Pricing Section and has more than 16 years of JPL/NASA experience in cost estimating and analysis, system engineering and software development; Independent Cost Estimates, parametric cost estimating, cost research, and risk analysis. Mr. Schmidt received his B.S, in Aerospace Engineering, from University of California Los Angeles (UCLA).

7.4 ACRONYM LIST

ACT	Alliance for Coastal Technologies
ADCP	Acoustic Doppler Current Profiler
AOML	Atlantic Oceanographic and Meteorological Laboratory
AOOS	Alaska Ocean Observing System
AUV	Autonomous Underwater Vehicle
BOB	Basic Observation Buoy
BOE	Basis of Estimate
BOEMRE	Bureau of Ocean Energy Management, Regulation and Enforcement
BRM	Business Reference Model
BY	Base Year
CARD	Cost Analysis Requirements Document (CARD)
CARICOOS	Caribbean Coastal Ocean Observing System
CD	Compact Disc
CeNCOOS	Central and Northern Coastal Ocean Observing System
CO-OPS	Center for Operational Oceanographic Products and Services
COSEE	Centers for Ocean Sciences Education Excellence
COSEE-AK	Centers for Ocean Sciences Education Excellence- Alaska
COSEE-FL	Centers for Ocean Sciences Education Excellence- Florida
COSEE-SE	Centers for Ocean Sciences Education Excellence-Southeast
COTR	Contracting Officer's Technical Representative
COTS	Commercial Off The Shelf
CRM	Customer Relationship Management
CSREES	U.S. Department of Agriculture, Cooperative State Research, Education, and Extension Service
CTD	Conductivity-Temperature-Depth
DAC	U.S. IOOS Data Assembly Center (DAC)
DEV	Development
DMAC	Data Management and Communications
DOE	U.S. Department of Energy
DOS	U.S. Department of State
DOT	U.S. Department of Transportation
DRM	Data Reference Model
EARTH	Education and Research, Testing Hypotheses
eMOLT	Environmental Monitors on Lobster Traps
EPA	Environmental Protection Agency
ESR	Earth and Space Research
FDA	U.S. Food and Drug Administration

FEA	Federal Enterprise Architecture
FFO	Funds from Operations
FL	Florida
FTE	Full-Time Equivalent
GCOOS	Gulf of Mexico Coastal Ocean Observing System
GDP	Global Drifter Program
GEOSS	Global Earth Observation System of Systems
GLOS	Great Lakes Observing System
GML	Geography Markup Language
GOES	Geostationary Operational Environmental Satellite
GoMOOS	Gulf of Maine Ocean Observing System
GOOS	Global Ocean Observing System
GPS	Global Positioning System
HFR	High Frequency Radar
HOV	Human Occupied Vehicle
HW/SW	Hardware/Software
I&T	Integration and Test
ICE	Independent Cost Estimate
IEOS	U.S. Integrated Earth Observation System
I/F	Interface
INS	Inertial Navigation System
IOOC	Integrated Ocean Observation Committee
IOOS	Integrated Ocean Observing System
ISO	International Organization for Standardization
IT	Information Technology
JCS	Joint Chiefs of Staff
JPL	Jet Propulsion Laboratory
KML	Keyhole Markup Language
LIDAR	LIght Detection And Ranging
M&A	Modeling and Analysis
MARACOOS	Mid-Atlantic Regional Association Coastal Ocean Observing System
MMC	Marine Mammal Commission
MOA	Marine Operations Center, Atlantic
MOP	Marine Operations Center, Pacific
MOU	Memorandum of Understanding
NANOOS	Northwest Association of Networked Ocean Observing Systems
NASA	National Aeronautics and Space Administration
NDBC	National Data Buoy Center

NEFSC	Northeast Fisheries Science Center
NERACOOS	Northeastern Association of Networked Ocean Observing Systems
NetCDF	Network Common Data Form
NFRA	National Federation of Regional Associations
NGO	Non-Governmental Organization
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPOESS	National Polar-orbiting Operational Environmental Satellite System
NSF	National Science Foundation
O&M	Operations and Maintenance
OAR	Office of Oceanic and Atmospheric Research
OCS	Office of Coast Survey
OGC	Office of General Counsel
OMB	Office of Management and Budget
ONR	Office of Naval Research
OOI	Ocean Observatories Initiative
OPM	Office of Personnel Management
OPS	Operations
PacIOOS	Pacific Islands Ocean Observing System
PCE	Program Cost Estimate
PDS	Planetary Data System
PI	Principal Investigator
PO.DAAC	Physical Oceanography Distributed Active Archive Center
POES	Polar-orbiting Operational Environmental Satellite
PRM	Performance Reference Model
QA	Quality Assurance
QC	Quality Control
R&D	Research and Development
RA	Regional Associations
REMUS	Remote Environmental Measuring UnitS
ROM	Rough Order of Magnitude
ROV	Remotely Operated Vehicle
RY	Real Year
SAR	Search and Rescue
SCCOOS	Southern California Coastal Ocean Observing System
SECOORA	Southeast Coastal Ocean Observing Regional Association
SLA	Service Level Agreement
SMCC	Southern Maine Community College

SRM	Service Component Reference Model
T-AGOS	tactical auxiliary general ocean surveillance
TRM	Technical Reference Model
TUV	Towed Underwater Vehicle
UNOLS	University National Oceanographic Laboratory System
URL	Uniform Resource Locator
USACE	U.S. Army Corps of Engineers
USARC	U.S. Arctic Research Commission
U.S.C.	United States Code
USCG	U.S. Coast Guard
USGS	U.S. Geological Survey
VA	Virginia
WA	Washington
WBS	Work Breakdown Structure
WHOI	Woods Hole Oceanographic Institute
XML	Extensible Markup Language

7.5 ASSET GAP ANALYSIS

The ICE team analyzed the assets currently collecting data and compared them to proposed future asset needs to determine a gap. Only new assets along with their operations and maintenance that augment the current capability are considered part of that gap. However, many assets are currently in place requiring scheduled upgrades and replacements. These upgrades and replacements were not included.

Table 7.5-1 identifies the uninflated dollar values of asset gaps (in $K). The table was created from the *WBS Matrix_Input* tab of the *IOOS_Cost_Matrix_Final_120502.xlsm* workbook and uses the same row titles. Referencing the original workbook can identify abbreviated names.

Most Federal contributors did not provide information regarding specific assets. Therefore, no analysis was performed, as is indicated in the table. In addition, the absence of other selected agencies and assets indicates that their current capability meets proposed needs; therefore, no gap was identified.

Table 7.7-1: Asset Gap Analysis; values are in uninflated $K; row titles are referenced from the *WBS Matrix_Input* sheet of the *IOOS_Cost_Matrix_Final_120502.xlsm* workbook.

Title as referenced from WBS Matrix_Input sheet of IOOS_Cost_Matrix_Final_120501.xlsm workbook	Year 1 FY12	Year 2 FY13	Year 3 FY14	Year 4 FY15	Year 5 FY16	Year 6 FY17	Year 7 FY18	Year 8 FY19	Year 9 FY20	Year 10 FY21	Year 11 FY22	Year 12 FY23	Year 13 FY24	Year 14 FY25	Year 15 FY26	Total ($K)
1.1.4.2 Federal assets																-
1.1.4.2.1 NOAA																-
Chesapeake	350	350	350	350	350	350	350	350	350	350						3,500
CORS (Cont	200	200	200	200	200	200	200	200	200	200						2,000
GOES (Geos	617,390	759,984	895,607	779,354	450,000	150,000	-	-	-	-						3,652,335
GOOS GLOSS	-	100	100	100	50	-	-	-	-	-						350
GOOS Ocean	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500						15,000
HYDRO (Hyd	42,300	-	-	-	-	-	-	-	-	-						42,300
Jason Ocea	2,000	47,300	49,900	53,800	-	-	-	-	-	-						153,000
NOP (Natio	-	-	84,182	-	-	-	-	-	-	-						84,182
RAMA: The	95	350	350	400	450	450	500	-	-	-						2,595
1.1.4.2.2 USACE																-
USACE Coastal Data Info. Program (CDIP)				10	20	30	40	50	60	70						280
USACE Mobile District Water Level Gauges	82	30	30	31	32	33	34	35	36							343
1.1.4.2.3 NSF																-
1.1.4.2.4 NASA																-
1.1.4.2.5 ONR																-
1.1.4.2.6 BOEMRE																-
1.1.4.2.7 USCG																-
1.1.4.2.8 USGS																-
1.1.4.2.9 DOE																-
1.1.4.2.10 EPA																-
1.1.4.2.11 MMC																-
1.1.4.2.12 JCS																-
1.1.4.2.13 CSREES																-
1.1.4.2.14 DOS																-
1.1.4.2.15 DOT																-
1.1.4.2.16 FDA																-
1.1.4.2.17 USARC																-
1.1.4.3 Non-federal assets																-
1.1.4.3.3 CARAICOOS																-
CARAICOOS WeatherFlow Meteo stations	10	10	10	10	10	10	10	10	10	10						100
CARAICOOS Automated stream flow/water quality station	10	10	10	10	10	10	10	10	10	10						100
CARAICOOS U Maine GoMOOS type buoys	50	50	50	50	50	50	50	50	50	50						500
CARAICOOS Wave and Sea Surface Temperature buoys	20	20	20	20	20	20	20	20	20	20						200
CARAICOOS Redeployable instrument array	8	8	8	8	8	8	8	8	8	8						75
CARAICOOS Diagnostic monitoring stations	9	9	9	9	9	9	9	9	9	9						85
1.1.4.3.4 CeNCOOS																-
CeNCOOS Shore stations - Weather	1	1	1	1	1	1										6
CeNCOOS HRF	170	170	170	170	170	170										1,020
1.1.4.3.5 GCOOS																-
GCOOS Airborne Products	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000						10,000
1.1.4.3.6 GLOS																-

Values unknown / not estimated

Table 7.7-1: Asset Gap Analysis; values are in uninflated $K; row titles are referenced from the *WBS Matrix_Input* sheet of the *IOOS_Cost_Matrix_Final_120502.xlsm* workbook.

Title as referenced from WBS Matrix_Input sheet of IOOS_Cost_Matrix_Final_120501.xlsm workbook	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Total
	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22	FY23	FY24	FY25	FY26	($K)
GLOS Cruises (5-Great Lakes)	50	50	50	50	50	50	50	50	50	50						500
GLOS Remote Sensing	100	100	100	100	100	100	100	100	100	100						1,000
1.1.4.3.9 NERACOOS																-
NERACOOS Drifters	75	75	75	75	75	75	75	75	75	75						750
1.1.4.3.10 PacIOOS																-
PacIOOS Waverider Buoy	75	75	75	75	75	75	75	75	75	75						750
PacIOOS Water Level Station	15	15	15													45
PacIOOS Nearshore Water Quality Sensor	65	65	65	65	65	65	65	65	65	13						598
PacIOOS Multipurpose Water Quality Sensor	70	70	70	70	70	70										420
PacIOOS Harbor Monitoring System	34	34	17	17	17	17	17	17	17	17						204
PacIOOS Acoustic Receiver (fish)	32	32	32	32	32	32	32	32	32	32						315
PacIOOS Observatory Sensors	21	15	15	15	15	15	15	15	15	15						156
PacIOOS Sea Glider	170	170	170	170												680
PacIOOS Wave Glider	230	230														460
PacIOOS AUV	450															450
PacIOOS Fish Tags	200	200	200	200	200	200	200	200	200	200						2,000
PacIOOS HFR	200	200	200	200	200	100	100	100	100	100						1,500
PacIOOS AIS Receiver	2	2	2	2	2	2	2	1	1	1						17
PacIOOS Coastal Camera	10	10	10	10	10	10	10	10								80
1.1.4.3.11 SCCOOS																-
SCCOOS HFR	125	125	125	125	125	125	125									875
2. Operations and Sustainment																-
2.2.1 Observing Systems Ops																-
2.2.1.2 Federal																-
NOAA																-
Chesapeake	-	350	700	1,050	1,400	1,750	2,100	2,450	2,800	3,150	3,150	3,150	3,150	3,150	3,150	31,500
CORS (Cont		200	400	600	800	1,000	1,200	1,400	1,600	1,800	1,800	1,800	1,800	1,800	1,800	18,000
GOES (Geos	-	-	-	-	101,662	82,863	57,454	54,770	52,086	38,557	34,645	30,733	26,822	20,000	16,000	515,593
GOOS GLOSS	1,371	29	129	229	329	329	329	329	329	329	329	329	329	329	329	5,377
Jason Ocea		20,000	20,000	140,000	139,300	120,000	100,000	-	-	-	-	-	-	-	-	539,300
NOP (Natio	-	-	-	84,182	84,182	84,182	84,182	84,182	84,182	84,182	84,182	84,182	84,182	84,182	84,182	1,010,184
RAMA: The		95	445	795	1,195	1,645	2,095	2,595	2,595	2,595	2,595	2,595	2,595	2,595	2,595	27,030
USACE																-
USACE Coastal Data Info. Program (CDIP)					40	80	120	170	220	270	320	370	420	470	520	3,000
USACE Mobile District Water Level Gauges		3	6	9	13	16	20	24	28	32	36	40	44	48	52	371

Table 7.7-1: Asset Gap Analysis; values are in uninflated $K; row titles are referenced from the *WBS Matrix_Input* sheet of the *IOOS_Cost_Matrix_Final_120502.xlsm* workbook.

Title as referenced from WBS Matrix_Input sheet of IOOS_Cost_Matrix_Final_120501.xlsm workbook	Year 1 FY12	Year 2 FY13	Year 3 FY14	Year 4 FY15	Year 5 FY16	Year 6 FY17	Year 7 FY18	Year 8 FY19	Year 9 FY20	Year 10 FY21	Year 11 FY22	Year 12 FY23	Year 13 FY24	Year 14 FY25	Year 15 FY26	Total ($K)
NSF																-
NASA																-
ONR																-
BOEMRE																-
USCG																-
USGS																-
DOE																-
EPA																-
MMC																-
JCS																-
CSREES																-
DOS																-
DOT																-
FDA																-
USARC																-
2.2.1.3 Non-federal assets																-
2.2.1.3.3 CARAICOOS																-
CARAICOOS WeatherFlow Meteo stations	3	3	7	10	13	17	20	23	26	30	30	30	30	30	30	300
CARAICOOS Automated stream flow/water quality station	10	20	30	40	50	60	70	80	90	100	100	100	100	100	100	1,050
CARAICOOS U Maine GoMOOS type buoys	45	90	135	180	225	270	315	360	405	450	450	450	450	450	450	4,725
CARAICOOS Wave and Sea Surface Temperature buoys	6	12	18	24	30	36	42	48	54	60	60	60	60	60	60	630
CARAICOOS Redeployable instrument array	6	12	18	24	30	36	42	48	54	60	60	60	60	60	60	630
CARAICOOS Diagnostic monitoring stations	1	1	2	2	3	3	4	4	5	5	5	5	5	5	5	53
2.2.1.3.4 CeNCOOS																-
CeNCOOS Shore stations - Weather	1	2	3	4	5	6	6	6	6	6	6	6	6	6	6	75
2.2.1.3.10 PacIOOS																-
PacIOOS Waverider Buoy	14	28	42	56	70	84	98	112	126	140	140	140	140	140	140	1,470
PacIOOS Water Level Station	4	7	11	11	11	11	11	11	11	11	11	11	11	11	11	147
PacIOOS Nearshore Water Quality Sensor	30	42	54	66	130	90	102	114	126	138	138	138	138	138	138	1,582
PacIOOS Multipurpose Water Quality Sensor	-	17	34	51	68	85	102	102	102	102	102	102	102	102	102	1,173
PacIOOS Harbor Monitoring System	9	12	15	18	21	24	27	30	33	36	36	36	36	36	36	405
PacIOOS Acoustic Receiver (fish)	21	42	63	84	105	126	147	168	189	210	210	210	210	210	210	2,205
PacIOOS Sea Glider	-	120	240	360	480	480	480	480	480	480	480	480	480	480	480	6,000
PacIOOS Wave Glider	16	32	32	32	32	32	32	32	32	32	32	32	32	32	32	464
PacIOOS AUV	-	225	225	225	225	225	225	225	225	225	225	225	225	225	225	3,150
PacIOOS Fish Tags	200	400	600	800	1,000	1,200	1,400	1,600	1,800	2,000	2,000	2,000	2,000	2,000	2,000	21,000
PacIOOS HFR	40	50	60	70	80	90	100	110	120	130	130	130	130	130	130	1,500
PacIOOS AIS Receiver	1	2	3	4	5	6	7	8	9	9	9	9	9	9	9	92
PacIOOS Coastal Camera	-	2	4	6	8	10	12	14	16	16	16	16	16	16	16	168
2.2.1.3.11 SCCOOS																-
SCCOOS HFR	-	38	76	114	152	190	228	266	266	266	266	266	266	266	266	2,926
2.2.1.3.12 SECOORA																-
Annual Totals	668,894	834,392	1,058,067	1,067,272	786,577	449,720	255,564	153,740	151,995	139,324	131,562	127,704	123,846	117,079	113,133	**6,178,870**