ORION CI
Conceptual Network Design

May 31, 2006

CI Design Subcommittee

CI Conceptual Architecture Design Team

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Design Objectives

- Develop a set of information system capabilities
  - June 1, 2006
- Develop conceptual level design to support the OOI systems operations and RFP development
  - June 1, 2006
- Develop a CI Work Breakdown Structure
  - Before June 15, 2006
- Create resource estimates for each line in the WBS to prepare a Rough Order of Magnitude cost and timeline for the project
  - June ~15, 2006

Design Methodology

- Requirements
  - ORION CI, RCO, DMAC, MBARI: SSDS/SIAM/BRBS, VENUS, NEPTUNE Canada, LEAD
- Concepts of Operations
- Dept. of Defense Architecture Framework, DoDAF
  - Operational activities
  - Organizational and Operational Nodes
  - Dictionary
- WBS
  - System components
  - Engineering Lifecycle
  - Integrations Points
- Cost
  - Model complexity, maturity and dependency
  - Use domain experts for comparison costing

Use of DoDAF

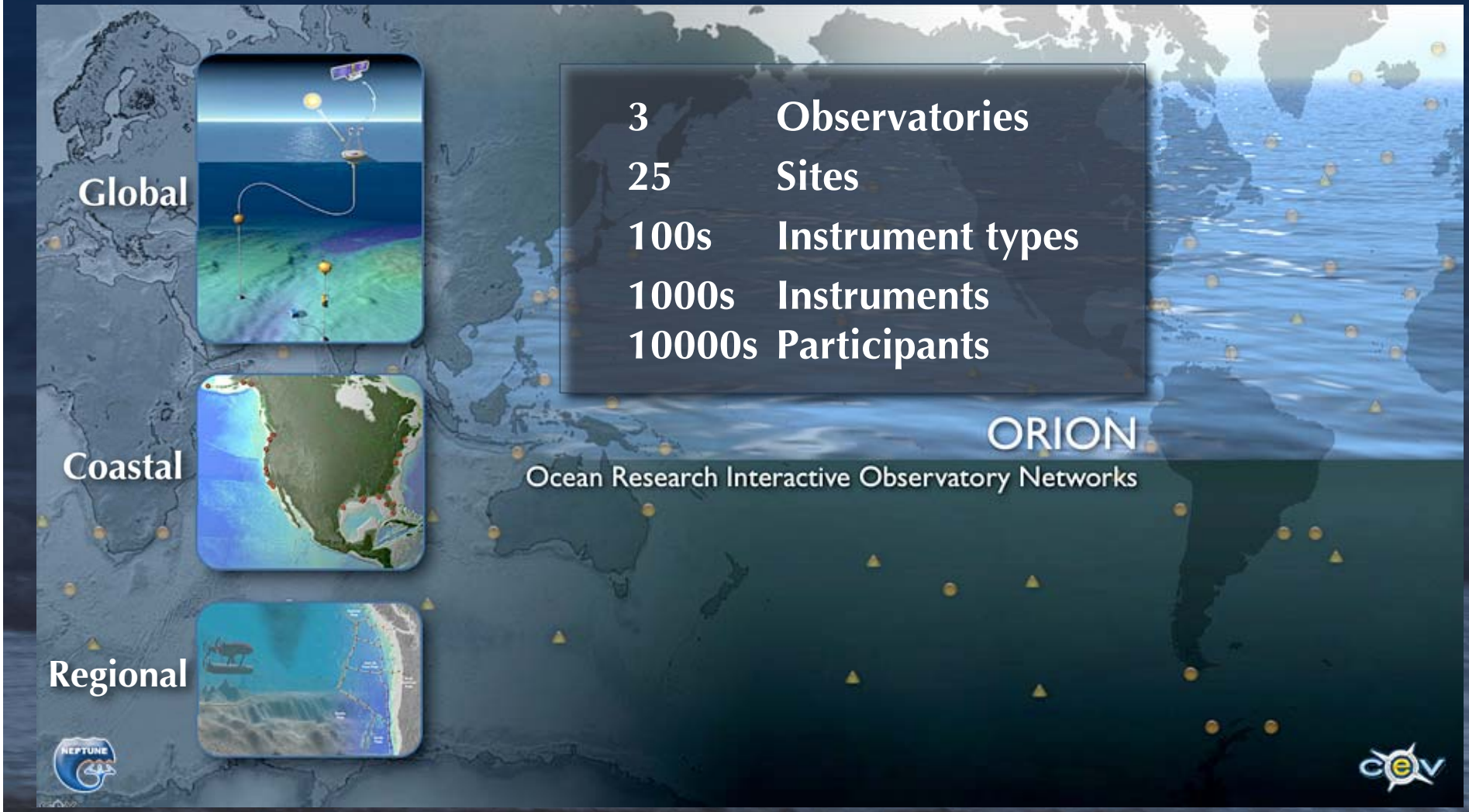
- Identify the main areas of Research Activity, Internal/External lines of Operations, and/or Support Functions
- Describe the operations that are normally conducted in the course of achieving an experiment or research goal
- Characterize the command, governance, and business relationships among the human, organizations, and organizational type roles
- Depict the operational nodes, including organizations, with need lines between those nodes that indicate a need to exchange information

CI Conceptual Architecture Deliverables
http://marinemetadata.org/orion

- AV-1: Overview
  - Provides context for other documents
- AV-2: Integrated Dictionary
  - Containing many key terms used in the other architecture documents.
- Concept Of Operations
  - Descriptive scenarios showing the architecture in use
- OV-1: Operations Overview
  - High-level overview of system, major components, and interactions
- OV-2: Operational Node Connectivity
  - Show relationships between Operational components
- OV-4: Organizational Node Connectivity
  - Show relationships between internal and external Organizations
- OV-5: Operations Activity
  - Describes the major interactions between system components
- ORION CI Requirements
  - Derived requirements from above documents and the distilled sources
- ORION CI Source Requirements
  - Requirement distilled from 9 observing system requirements documents

New Meaning to the Connected Planet

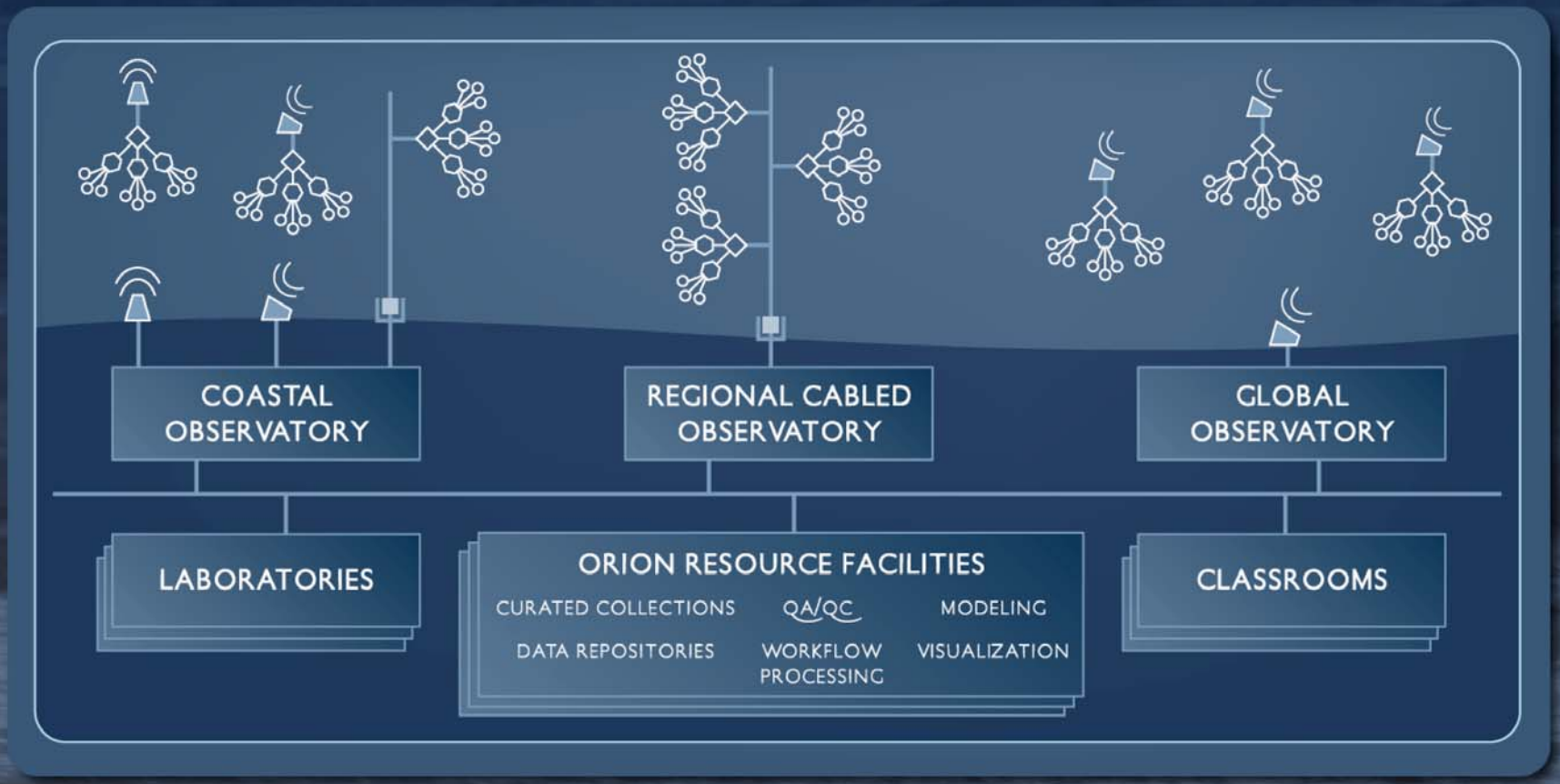
- Beginning of an epoch - **Instrumented Earth**
- A globally accessible **Continuous Signal**
- Representing the **Now State** of the Earth System
- Informing our understanding of its
  - **Past, Present and Predicted Future**
- Signal scales exponentially for the foreseeable future
  - **Quantity, Resolution, Coverage and Utility**


Global
Coastal
Regional
3 Observatories
25 Sites
100s Instrument types
1000s Instruments
10000s Participants
ORION
Ocean Research Interactive Observatory Networks

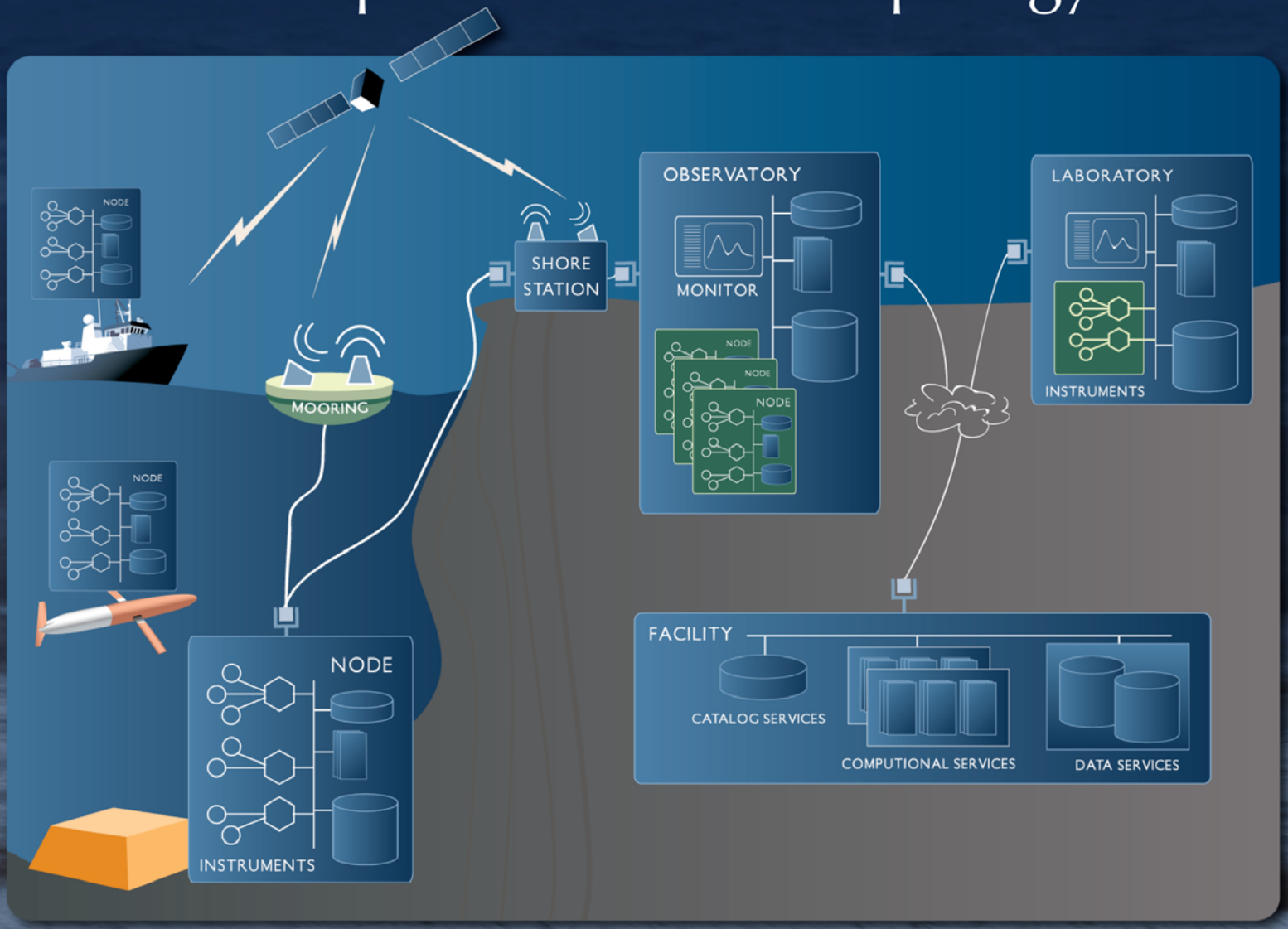
Expanding Role of Environmental Observing

- From individual expedition to collaborative observation
  - Long-term persistent presence, continuous 24/7 time series
  - Increasing numbers and diversity of sensors
  - Multiple, complex data streams
  - Many more types of users and applications
  - Ability to control instruments, observing systems, and large-scale experiments
- Ubiquitous data requiring greater differentiated expertise
  - From kilobits to terabytes in a matter of hours.
  - Collaborative discovery by groups of researchers with different vocabularies and expertise looking at complex data streams
- A need for cooperating networks of data/processing/analysis systems that are different than in the past

ORION Cyberinfrastructure Conceptual Network Design



Conceptual Network Topology



Observatory Network Objectives

- Facilitating direct & immediate interaction with Ocean
- Connecting & coordinating operations between Observatories and with Science & Education
- Providing scientists with the capability to observe and respond to conditions in the ocean
  - Couple the observation, modeling and mission control systems
- By addressing the issues of
  - Observatory resource management,
  - Mission command and control,
  - Knowledge (data) management and distribution,
  - Meaningful collaboration across a wide range of disciplines

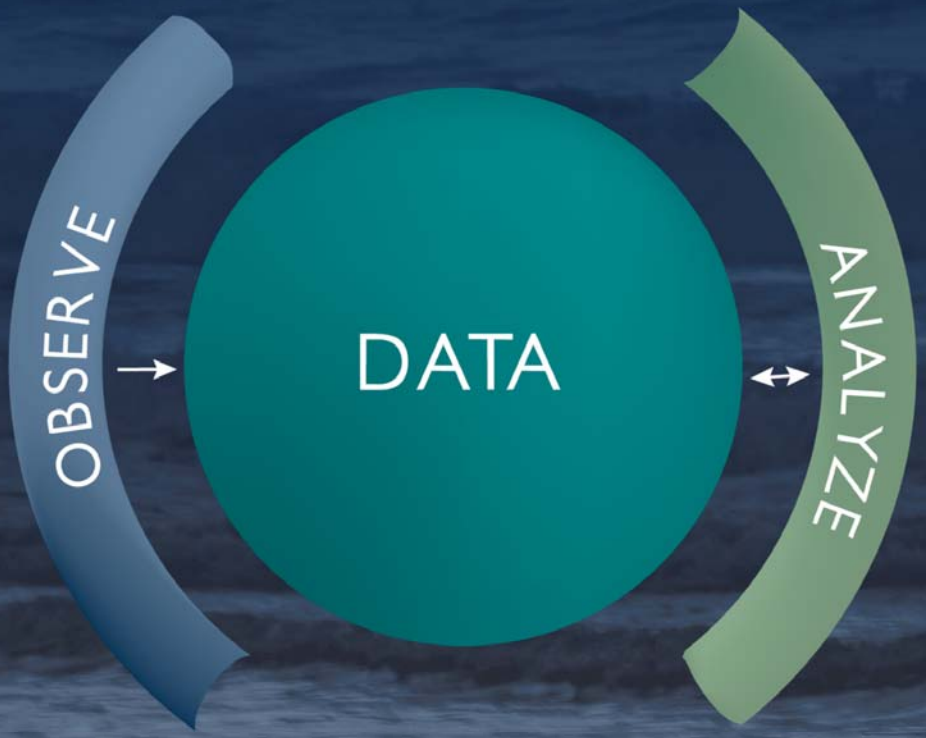
Design Principles

- The observing process has to be easier than it is now
- Strength of the collective comes from the power of the individual
  - Building on the architecture principles of the Internet and Personal Computing
  - Innovation comes from self interest
- Develop Locally - Deploy Globally
  - Units of the system to incorporate new functionality without requiring others to change
  - Locally developed capability is accessible globally
- Keep It Simple Stupid
  - One design pattern that works as a unit when on its own and in composition
  - One architecture that works across scales and implementations

Design Objectives

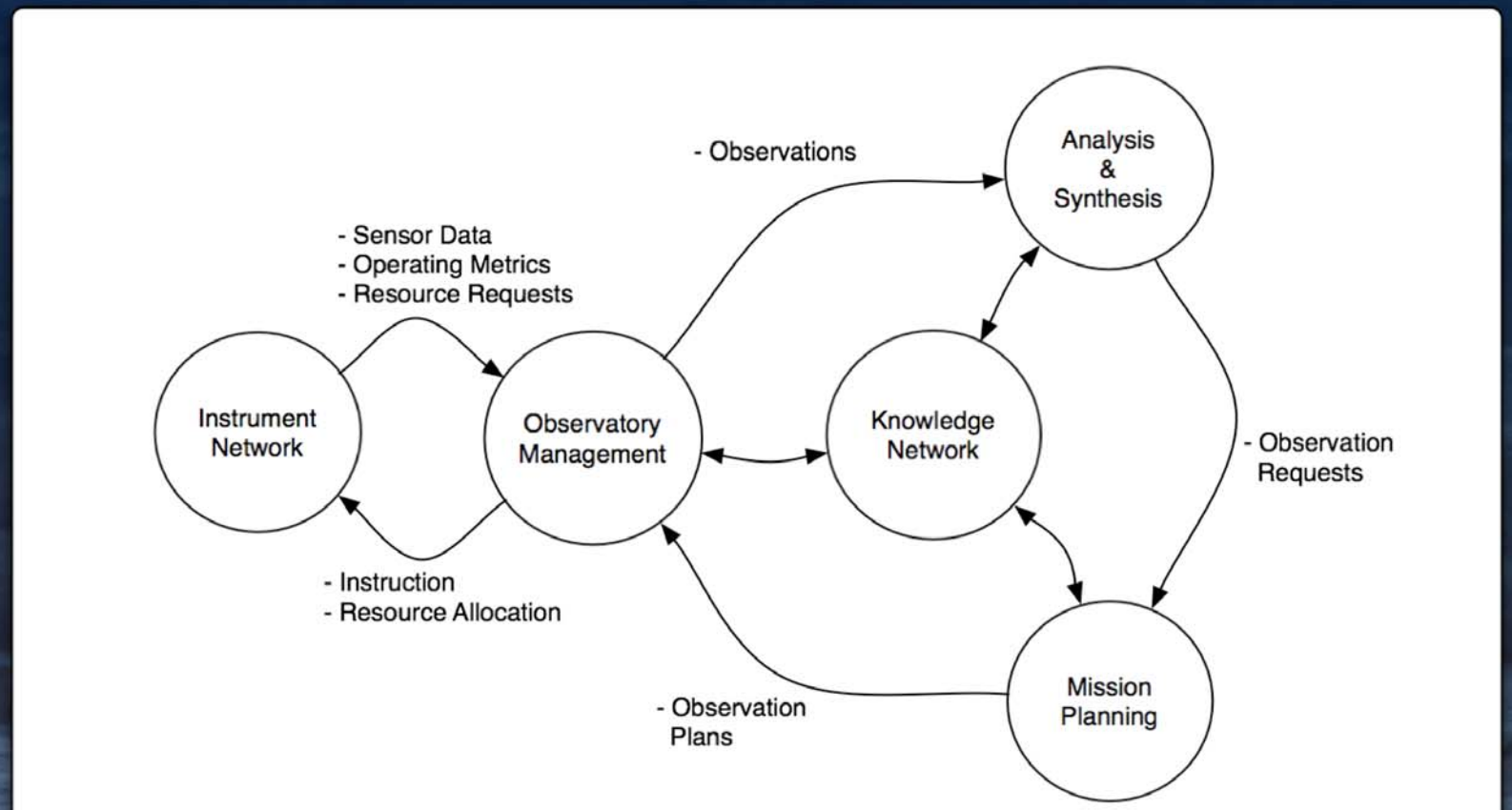
- Common Observatory Network Model
  - Open and transparent
  - Policy and composition a matter of declaration not design
- Common Component Model
  - Explicit ownership model
  - Ability to delegate: Authority, Capability, Operation
  - Visibility of operating state and past performance
- Common Operating Infrastructure Model
  - Communication,
  - Mediation,
  - Governance,
  - Knowledge,
  - Behavior

Ocean Observing System



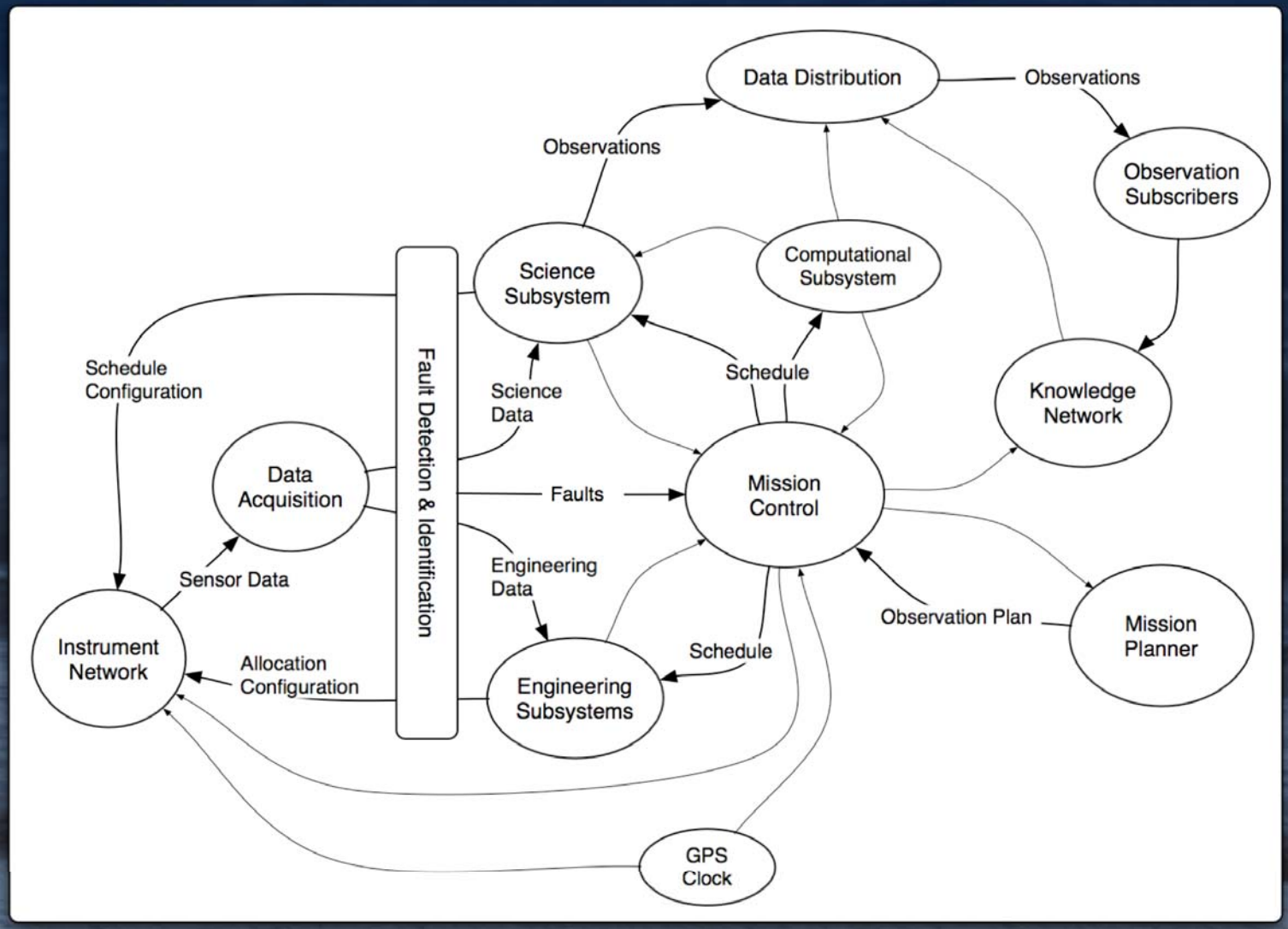
Ocean Observatory

Observatory Network Model

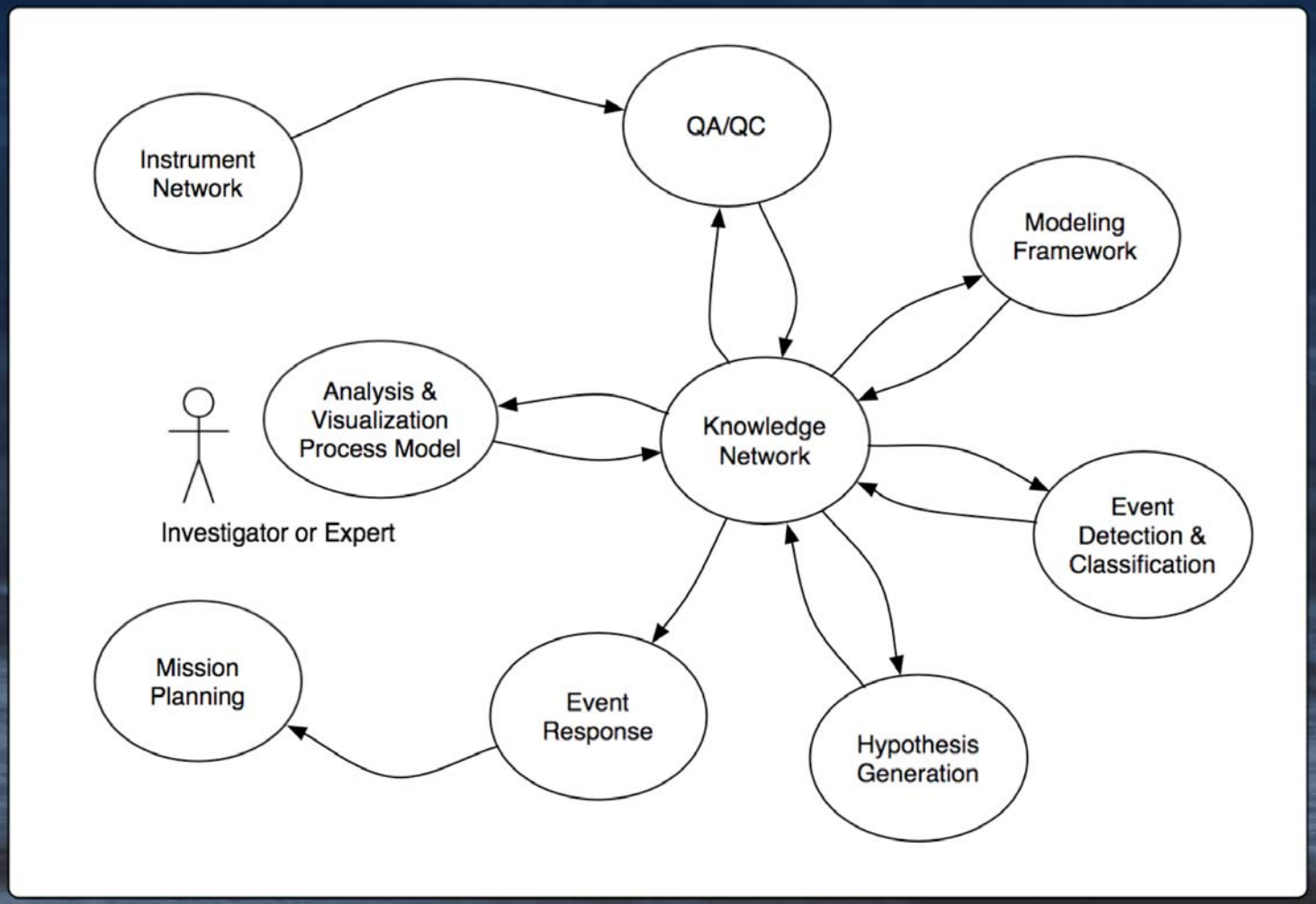


The Observatory | **The Laboratory** | **The Classroom** | **The Facility**

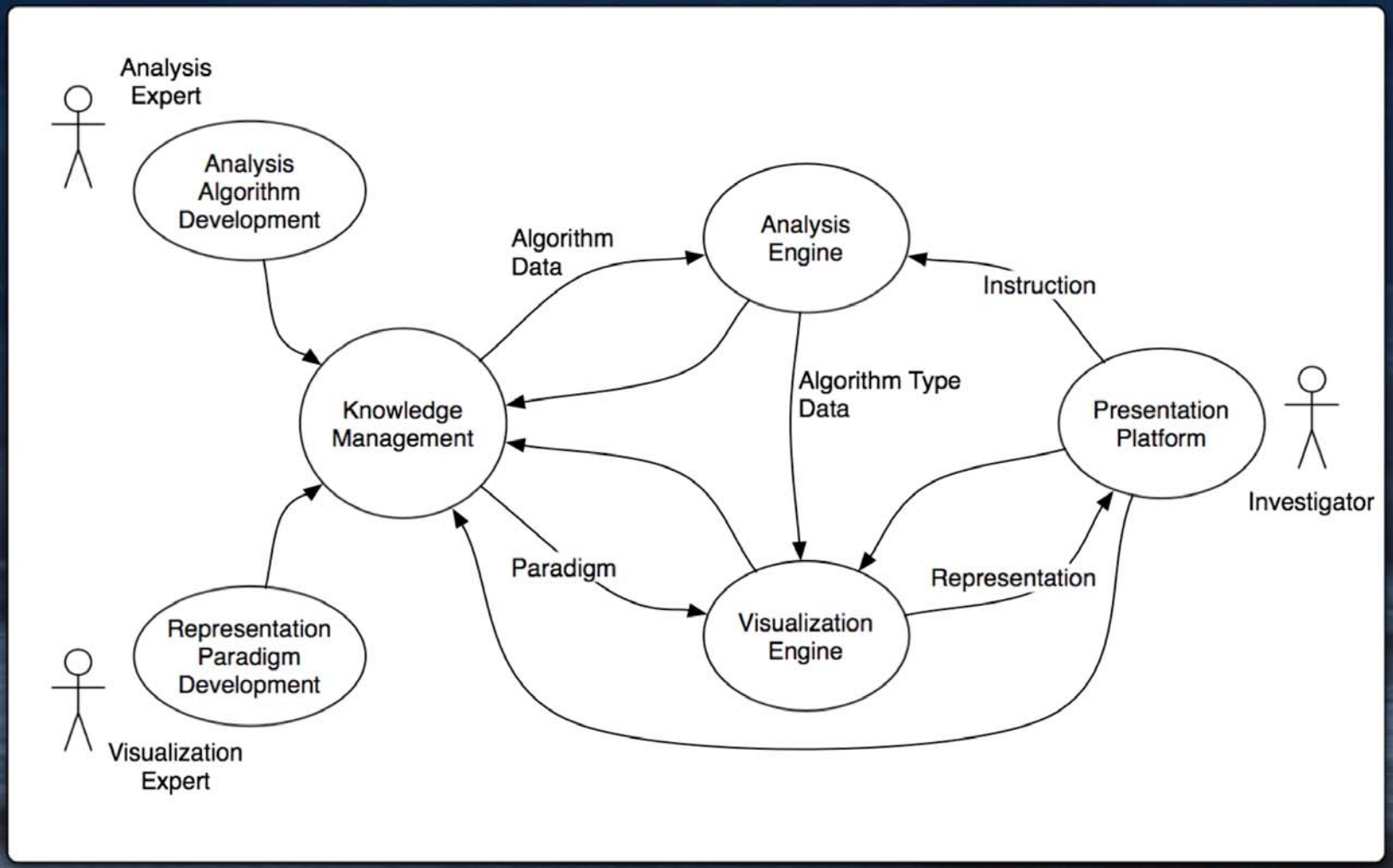
Observatory Management



Analysis & Synthesis

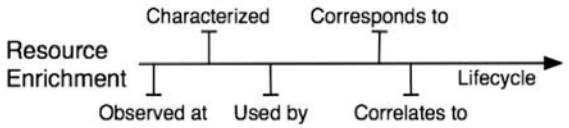


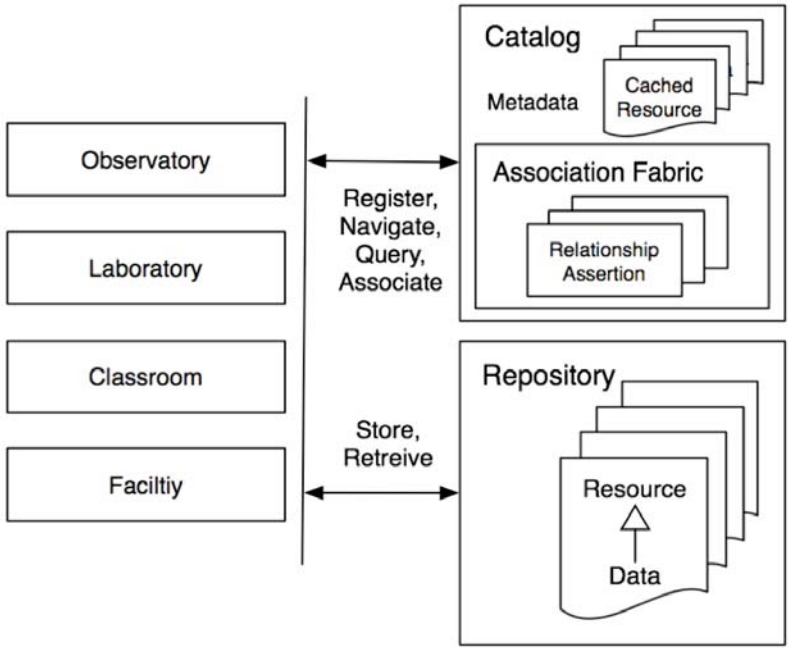
Analysis & Visualization Process Model



Knowledge Fabric

- Enrichment is a continuous process
- Data is only one class of Resource





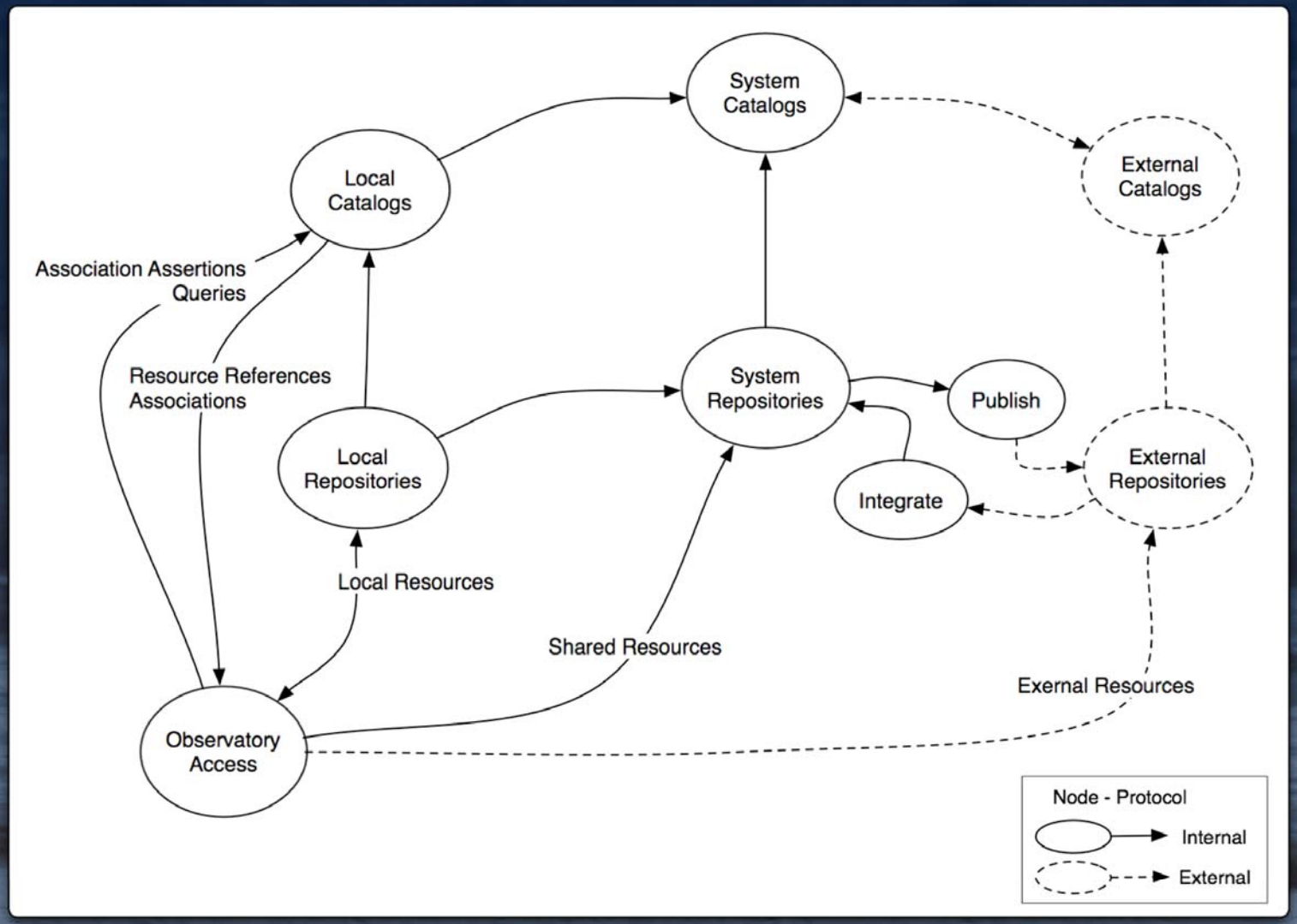
Descriptor	Association	Resource
Lat -Lon	Locates	Observation
Quality	Characterizes	Observation
Process	Cites Use of	Observation
Event	Corresponds to	Observation
User	Member of	Facility
Facility	Provides	Service
Service	Governed by	Policy
Observation	Routes to	Facility

Required: Ontology of Associations

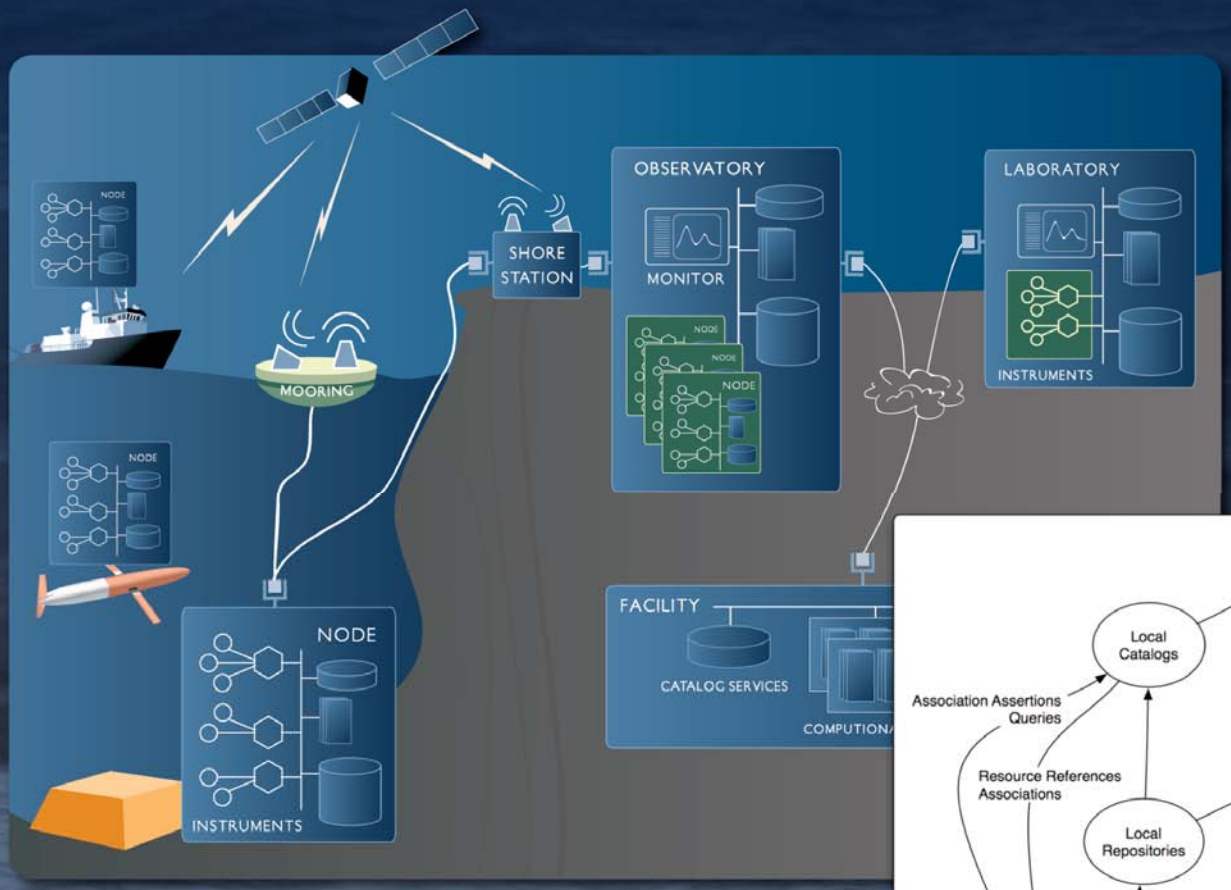
Goal: Currated Collection of Resources

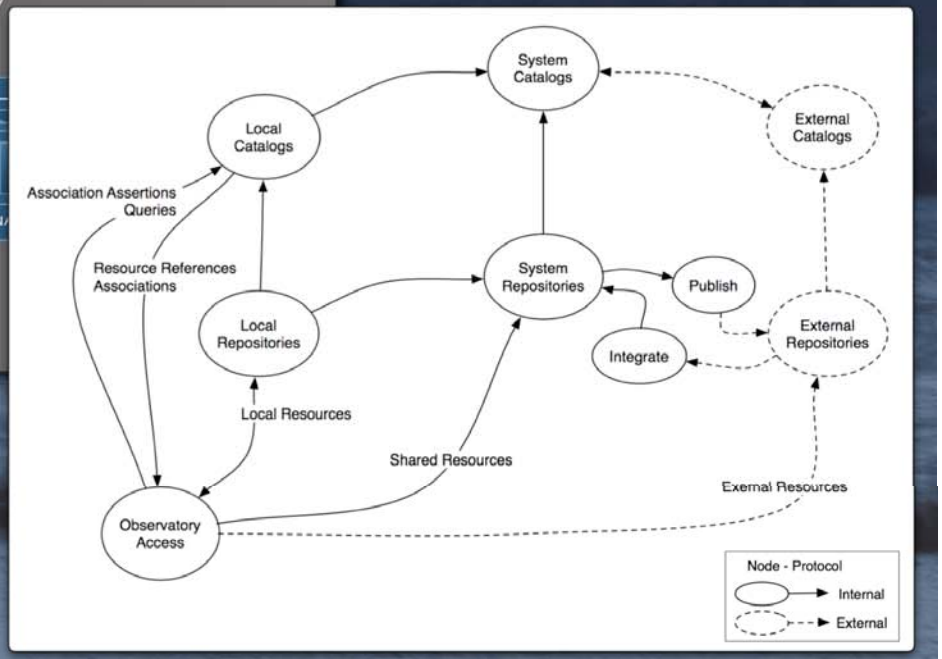
- What data has been correlated with this data?
- Where does this data route to when updated?
- What facilities provide this service and what are their policies?

Knowledge Network

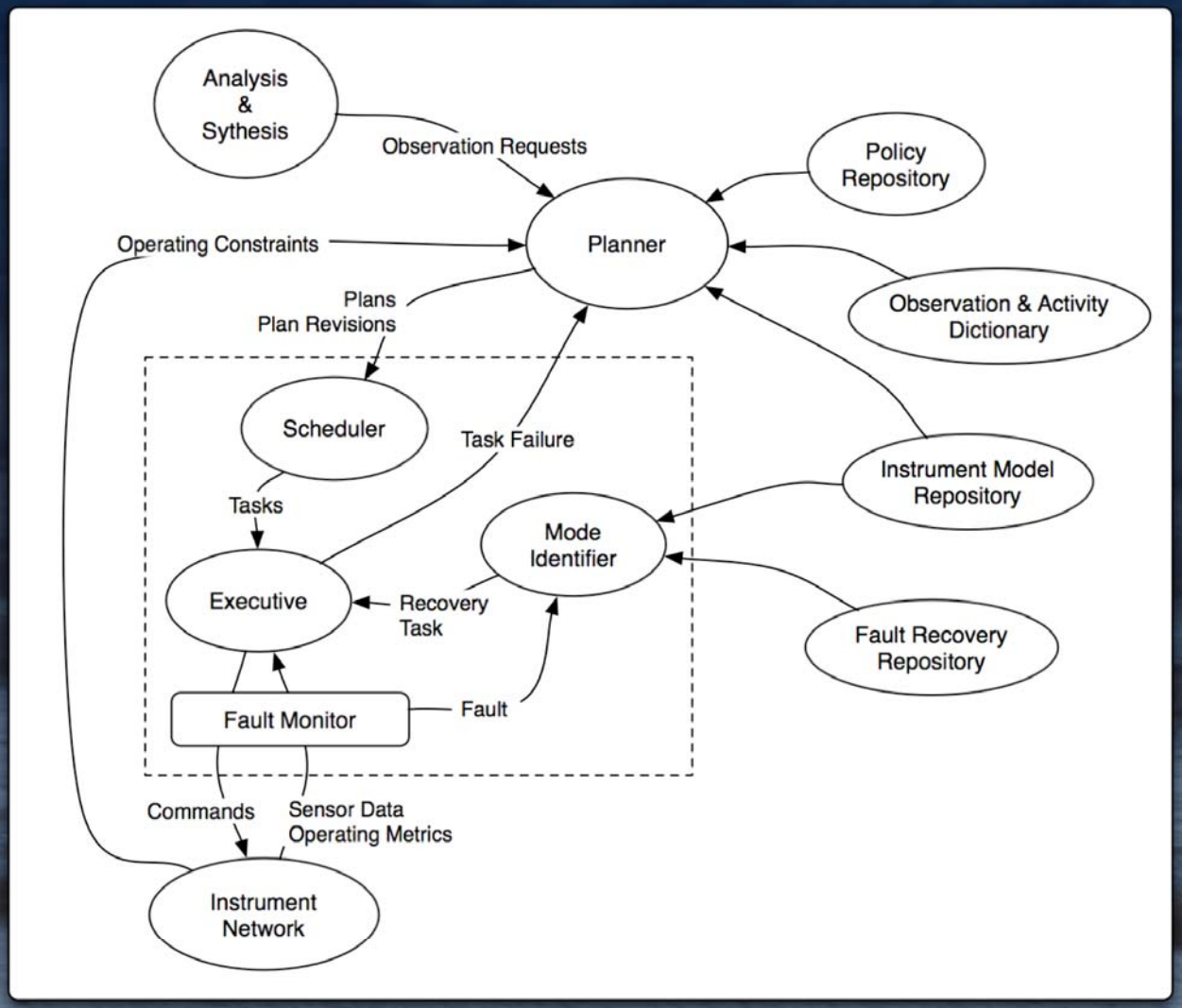


Knowledge Network Topology

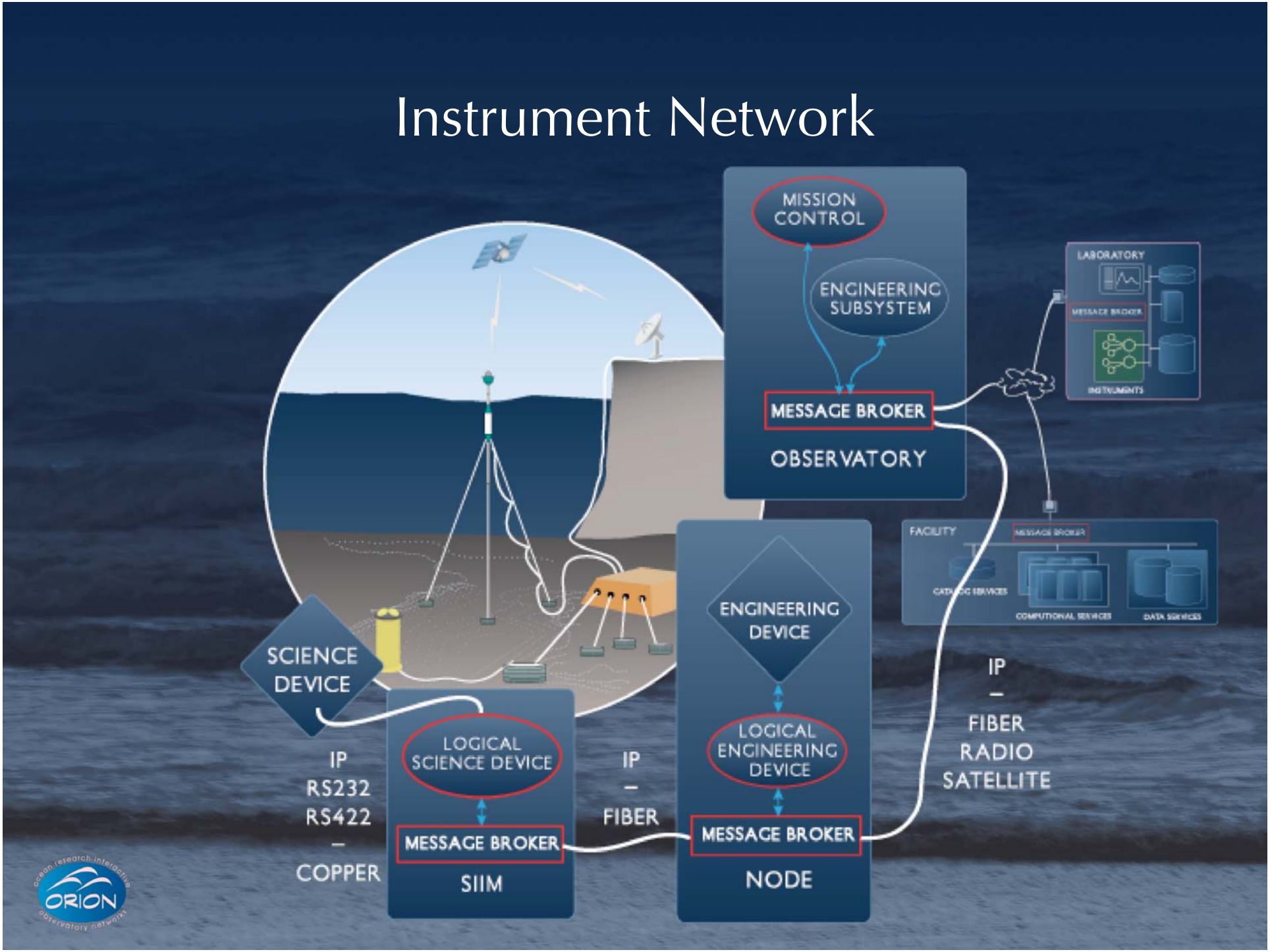




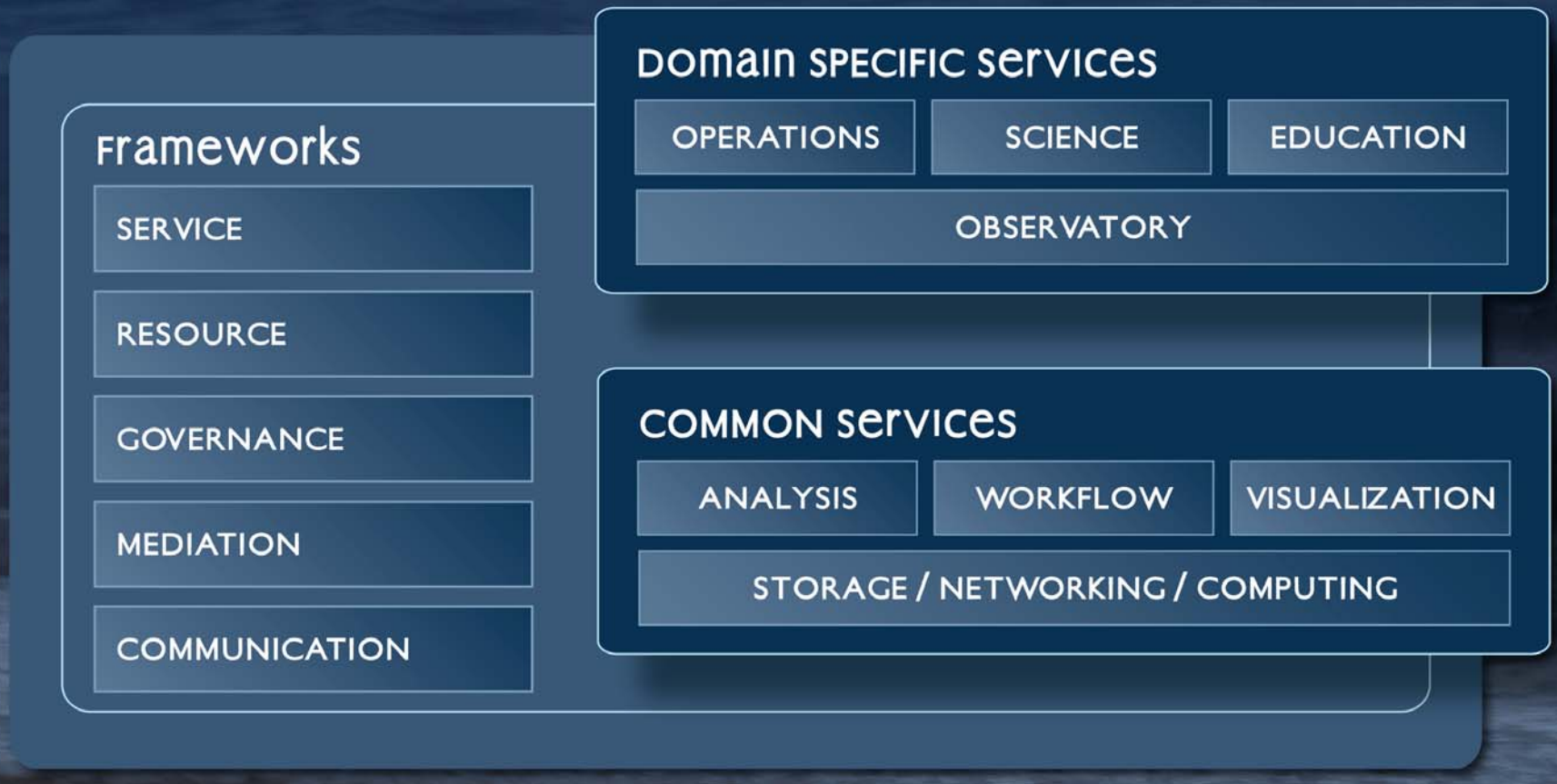
Mission Planning and Execution



Instrument Network



Service Oriented Enterprise Architecture



SOA Rationale

$A_{[i]} : S_{[j]} : R_{[k]}$

A : Application
S : Service
R : Resource

$S_c \xrightarrow[T_p]{D_p} S_p$

Messaging

S_c : Service Consumer
S_p : Service Provider
D_p : Data Protocol
T_p : Transport Protocol

$\nabla_A \neq \nabla_R$

$\nabla_S = 0$

∇ Rate of Evolution

Services are durable contracts

Usage drives the binding of Applications & Resources

Service Development Model

- Discovery
  - Expert Teams, Workshops,Use Case Scenarios, Requirements
- Specification
  - Definition, QoS, Constraints & Policies, Ownership
  - Operational Behavior & Usage Patterns
- Prototype
  - Science (use) Driven, Prioritized
- Implementation
  - Tool Chains, Model Driven Architecture
- Testing
  - Invocation Libraries, Simulated Service Providers
- Provisioning
  - Integration, Deployment, Training

Going Forward

- Some technical areas deserve extra attention
  - Incorporation of real time streaming data into scientific process
  - Specification and adoption of instrument services
  - Effective operation of systems of systems that will scale with the anticipated growth of ORION
  - Interfacing with external organizations and resources
- Implementing Organizations take this on
  - Evaluation and response to the most challenging tasks
  - Iterative deployments necessary to guarantee value
  - Collaborative development encouraged to maximize cohesiveness and success

Reasons for Confidence

- Open and transparent design process
- Ongoing review by external and internal experts and stakeholders
- Iterative functional deployments reflecting use priorities and system risks
- Significant existing expressions of system requirements
  - Science efforts on which to build (BIRN, GEON, CLEANER)
  - Many sophisticated commercial collaboration architectures, particularly in web domain (Google, Flikr, eBay, MySpace)
  - Pioneering efforts in ocean cyberinfrastructure (LOOKING on research side, NEPTUNE Canada in operation)
- Innovation will be focused on increased usability, effectiveness and reliability