SYSTEM REQUIREMENTS DOCUMENT

November 2007
DRAFT v2.0

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1. INTRODUCTION

1.1 Purpose

The *OOI System Requirements Document* (SRD) contains the system requirements for the Ocean Observatories Initiative (OOI) program. These requirements were derived from an iterative development process to define the system needed to satisfy the requirements in the *OOI Science User Requirements* (SUR) document. This document captures the top-level requirements and the lower-level requirements for the entire OOI system. The overarching system requirements are divided into general requirements and then all the “ilities” requirements needed to deliver a robust system that has an extended lifetime operating in the harsh marine environment.

1.2 Scope

This document defines the OOI System Requirements at a sufficient level of detail to support the development of a preliminary network design. The intent is that these requirements clearly specify the needs of the users of the system, but do not specify (or restrict) the design approach. System requirements development for OOI has occurred over approximately a four-year period. A series of conceptual designs were completed that helped the science community understand the impact of the various science requirements. The OOI Conceptual Network Design was finalized based on science ideas proposed in the request-for-assistance (RFA) proposals that were ranked highly. The science drivers captured in the SUR document trace down to a particular site what sensors are needed to perform the science. These requirements will be maintained in a DOORS (dynamic object oriented requirements system) database and will be linked to the subsystems requirements document during the next phase of the OOI development.

1.3 Maturity

At the Preliminary Design Phase both the SUR and the System Requirements have been developed and form the basis for the OOI Preliminary Network Design. As the program enters into the detailed engineering design phase the subsystem and component level requirements and the corresponding test documentation will be completed.

1.4 References

The following list of documents will be prepared based on the SRD.

1.4.1 OOI Subsystem Requirements

The *OOI Subsystem Requirements* are derived from the SRD and provides the subsystems design requirements (including sub-system block diagrams).

1.4.2 OOI Component Requirements

The OOI Component Requirements are derived from the SRD and OOI Subsystem Requirements and provides the component qualification requirements.

1.4.3 OOI Test Plans

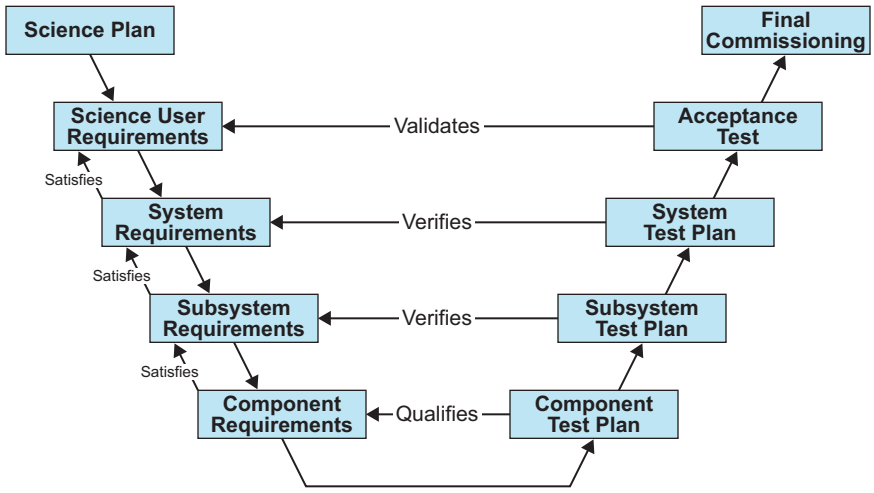
The OOI Test Plans are derived from the all of requirements documents and provide the following:

- Component Test Plan
- Subsystem Test Plan
- System Test Plan
- Acceptance Test Plan

The figure below shows the systems engineering requirements development and system testing V-Model. To manage complexity, development is undertaken in levels, with requirements playing a role at each level. Fundamental to the V-Model are the relationships between layers of requirements, the more detailed ones supporting the more detailed engineering phases. The requirements form the basis of the test program that will be accomplished from the component through the system level.

Traceability enables the traversal of related requirements, for instance, from the original science user requirements through system requirements, and into design and implementation. The traceability is intended to provide:

- How requirements are satisfied
- How requirements are tested
- The impact of changing requirements
- The impact of test failure



1.5 Conventions

Section / Sub-Section Names

Section Name	Code	Sub-Section Name	Code
System	S	System Science	S
		System Approach	SA
		Environment	EN
		Cost Effectiveness	CE
		Open Design	OD
		Support Services	SS
		Instruments General	IN
		Interoperability	I
		Expandability	E
		Maintainability	M
		Reliability	R
Section/Level Name	**Code**	**Sub-Level Name**	**Code**
Cyberinfrastructure	CI	Design Principles	PD
		“illities”	PI
		Cost Effectiveness	CE
		Operating Communications	OC
		Operating Mediation	OM
		Operating Governance Security	OS
		Operating Governance Policy Framework	OP
		Services Infrastructure Identity Management	II
		Services Infrastructure Policy Management	IP
		Resource Management – Characterization	IRC
		Resource Management – Discovery	IRD
		RM Notification/Publications/Subscription	IRP
		RM Persistence	IRE
		RM Top Level Resource Utilization	IRU
		RM Management Process	IRW
		Resource Collaboration Management	IS

Section/Level Name	Code	Sub-Level Name	Code
Coastal/Global	CGSN	General	G
		Power Network	PN
		Data Communications Network	CN
		Resource Time Distribution	TD
		Observatory Control	OC
		Data Quality Control and Calibration	DCCC
		Resource Science Instrument Interface	SII
		Security	S
		Community Instruments/Experiments	CIE
		Operations	O
		Reliability	R
		Environment	E
Section/Level Name	**Code**	**Sub-Level Name**	**Code**
Regional Scale Nodes	RSN	General	G
		Power Network	PN
		Data Communication Network	CN
		Resource Time Distribution	TD
		Observatory Control	OC
		Instrument Interface	II
		Security	S
		Operations	O
		Reliability	RE
		Environment	E

2. OOI System Requirements

Designations / Abbreviations:
TL = Top Level

ID Format:
XXXX-XXXX-### = Section Code-Sub-Section Code-ID Number

2.1 System Requirements (S)

ID		Requirements
System Science (S)		
S-S-1	TL	Provide an interactive, globally distributed and integrated observatory network to enable next-generation studies of the complex, interlinked physical, chemical, biological, and geological processes operating throughout the global ocean. Science User Requirements are in a separate document.
S-S-2	TL	The OOI shall observe phenomena at the spatial and temporal scales appropriate to the processes and systems being studied.
S-S-3	TL	The OOI shall consist of observatories operating over a continuum of spatial scales from coastal to regional to global
S-S-4	TL	Analysis of observations between observatories shall be facilitated by a common cyberinfrastructure
S-S-5		OOI observatories shall provide power, data communication and control infrastructure to support the science requirements
System Approach (SA)		
S-SA-1	TL	Maximize collaboration and cooperation between all Implementing Organizations via the Systems Engineering function.
S-SA-2		The RSN, CGSN, and Cyberinfrastructure Implementing Organizations shall be subject to all OOI System level Requirements
S-SA-3		The RSN, CGSN, and Cyberinfrastructure Implementing Organizations systems engineering team efforts shall be led by JOID Systems Engineer
Environment (EN)		
S-EN-1	TL	Remain operational during storms and extreme events Survive Category # storms, Sea State # Operate Category # storms, Sea State #
S-EN-2	TL	Noise/interference caused by the system infrastructure shall be specified and openly available to instrument designers.
S-EN-3		All OOI infrastructures shall be operable for minimum of [25] years with the appropriate maintenance
S-EN-4		OOI infrastructure shall be designed to remain operational during environmental conditions to be defined for each installation location
S-EN-4.1		OOI surface instruments shall remain operational through storm conditions common to their installed location
S-EN-4.2		OOI seafloor instruments shall remain operational through storm conditions common to their installed location
S-EN-4.3		OOI water column instruments shall remain operational through storm conditions common to their installed location

ID		Requirements
S-EN-4.4		OOI water column instruments shall remain operational in sustained currents common to their installed location
S-EN-4.5		OOI water column instruments shall remain operational in transient currents common to their installed location
S-EN-4.6		OOI infrastructure shall be designed to North American Earthquake Zone [4] standards.
S-EN-5		All OOI observatories shall include engineering sensors as required to collect data concerning observatory state- of-health
S-EN-6		All OOI observatories shall deliver state-of-health data to a shore-based operations center in near-real time
S-EN-7		All OOI observatory state-of-health data shall be publicly available in near-real time
S-EN-8		Minimize impact of infrastructure generated interference on instruments
S-EN-9		Minimize interference between instruments
Cost-effectiveness (CE)		
S-CE-1	TL	Minimize life-cycle cost during design
S-CE-2	TL	Maximize reuse of designs tested by the existing ocean observation networks, including MARS and Neptune Canada
S-CE-3	TL	Maximize use of common components between observatory elements
S-CE-4	TL	Design, installation, implementation, operating, and maintenance costs are to be considered for the purpose of minimizing life-cycle cost.
S-CE-5		Design, installation, implementation, operating, and maintenance costs shall be documented for all OOI infrastructure components
Open Design (OD)		
S-OD-1	TL	Open availability of OOI Observatory design specifications
S-OD-2	TL	Open availability of OOI Observatory instrument hardware interface specifications
S-OD-3	TL	Open availability of OOI Observatory data interfaces
S-OD-4		OOI Observatory element design specifications shall be publicly available
S-OD-5		OOI Observatory instrument hardware interface specifications shall be publicly available
S-OD-6		OOI Observatory data shall be freely available to the public after processing and calibration
Support Services (SS)		
S-SS-1	TL	Maximize integration of support services between Implementing Organizations as perceived by the end-user scientist/instrument owner
S-SS-2	TL	Provide standard, simulated test interfaces and testbeds for instruments users/ designers
S-SS-3	TL	Provide a facility for instrument calibration
S-SS-4		At a minimum, one simulator(s) and testbed(s) that emulate the instrument interface(s) shall be available to users.
S-SS-5		Each Implementing Organization shall provide support to scientists and instrument designers throughout the design, test, deployment, operations, and maintenance phases of OOI [at TBD level].

ID		Requirements
S-SS-6		One or more portable simulators that emulate the instrument extension shall be available to users.
S-SS-7		One or more facilities for instrument calibration shall be provided for calibration of instruments to be deployed on the OOI.
Instruments (IN) General		
S-IN-1	TL	Instruments located in high bio-fouling areas should be designed to maximize time between maintenance/cleaning.
S-IN-2		Maximum local currents shall be specified upon site selection and surveying
S-IN-3		Geo-technical properties of the sediment at each location shall be available
S-IN-4		Seafloor nodes shall be capable of operation in water with heavy sand loading
S-IN-5		Neither instruments nor the instrument interface shall use seawater as a current return path
Interoperability		
S-I-1	TL	Maximize the use of common instrument electrical (data and power) interfaces across the coastal, regional, and global systems
S-I-2	TL	Maximize the use of common software interfaces across the coastal, regional, and global systems
S-I-3		(Deleted)
S-I-4	TL	Establish data and communication compatibility with NEPTUNE-Canada
S-I-5	TL	Establish data and communication compatibility with IOOS
S-I-6	TL	Establish data and communication compatibility with EarthScope
S-I-7	TL	Establish scientific collaboration with ESONET
S-I-8		The coastal, regional, and global systems shall use common physical interfaces for the instrument power/data interfaces where possible
S-I-9		The Cyberinfrastructure Implementing Organization shall develop a standardized software interface applicable across the coastal, regional, and global systems
S-I-10		The RSN, CSN, and GSN shall utilize the standard software interface developed by the CI
S-I-11		Data shall be provided in a TBD standard format
S-I-12		The system design shall facilitate auto-discovery and auto-configuration of instruments where practicable
Expandability (E)		
S-E-1	TL	Allow for future expansion of the observatory to include new locations
S-E-2	TL	Allow for future expansion of the observatory to accommodate instruments with greater resource requirements
S-E-3	TL	Allow for future expansion of the observatory to include greater spatial coverage
SE-4	TL	Maximize the ability to expand science capabilities of system through the addition of fixed and mobile platforms and instruments
S-E-11	TL	Maximize ability to accommodate/interface with bottom tripods, surface piercing towers, surface/subsurface moorings, and borehole deployments.
S-E-12	TL	Maximize ability to expand spatial coverage of system through addition of nodes and/or new cable segments

ID		Requirements
S-E-13		Each science or extension connector shall be expandable using one or more secondary interfaces to allow each science node to interface to many of instruments
S-E-14		The system shall accommodate installation of additional science nodes
S-E-15		The cable segments shall accommodate installation of additional cable segments
Maintainability (M)		
S-M-1	TL	Maximize the time between servicing to the maximum extent allowed by budget and technology.
S-M-2	TL	Explore sharing maintenance costs with Neptune Canada and IOOS
S-M-3		(Deleted)
Reliability (R)		
S-R-1	TL	At a system level the OOI shall deliver data at rated capacity XX% of the time
S-R-2	TL	Provide at least single fault tolerance for all elements where practical
S-R-3	TL	To the extent practical, provide sufficient fault isolation to ensure that failures can be isolated to individual instruments nodes/ elements/ branches of the network
S-R-4	TL	Fully document all interruptions and notify affected parties
S-R-5		The operational status of the system shall be logged and publicly available
S-R-6		(Deleted)
S-R-7		The system shall be capable of providing 100% of the data 95% of the time in the absence of instrument failures
S-R-8		The system shall be designed to be modular and to minimize downtime due to maintenance with a goal of a scheduled and publicly announced maintenance period not to exceed 7 days per year per site
S-R-9		The system shall shut down instruments in a defined manner prior to scheduled maintenance or anticipated interruptions
S-R-10		The system shall provide for measurement logging and accessing of engineering data defining the system state
S-R-11		Provide a system design and implementation of continuous power and communications services to individual instruments without interruption or infrastructure failures causing interruption in attached cabled systems exceeding 18 days annually.
S-R-12		On critical sub systems a Failure Mode analysis and Reliability calculation shall be conducted.

3. Integrating Systems and Sub-Systems

Designations / Abbreviations:
TL = Top Level

ID Format:
XXXX-XXXX-### = Section Code-Sub-Section Code-ID Number

3.1 Cyberinfrastructure (CI)

ID		Requirements
Design Principles (PD)		
CI-PD-1	TL	The CI serves scientific investigation, discovery, innovation and education
CI-PD-2	TL	Development of the CI shall be science-driven
CI-PD-3		The CI shall support distributed resources and actors
CI-PD-4		The CI architecture shall be based on standard service-to-service protocols to the maximum possible extent
CI-PD-5		The CI shall be based on open standards and software to the maximum possible extent
CI-PD-6		Existing CI capabilities shall be leveraged to the maximum possible extent
CI-PD-7		CI services shall be designed for reuse in similar architectures
CI-PD-8		The CI architecture and implementation shall be platform-independent
CI-PD-9		The CI shall be designed to minimize the life cycle cost
CI-PD-10		All CI components shall be maintained under configuration control
CI-PD-11		The CI subsystems shall adhere to the interfaces defined by the CI architecture protocols (APIs)
CI-PD-12		Context-specific and context–independent documentation of CI services and components shall be provided
CI-PD-13		Self-describing interfaces, functions, and versions of CI tools that are backward compatible shall be provided
CI-PD-14		The CI shall accommodate local innovation that is capable of scaling to the community level
CI-PD-15		CI applications and tools shall be capable of operating independently of the CI infrastructure
CI-PD-16		The OOI shall seek to influence the direction of CI standards to effectively meet the needs of its users
CI-PD-17		A mechanism to solicit and receive user feedback about the CI shall be provided
CI-PD-18		All CI services and applications shall include documented resource/service interaction
The “ilities” (PI)		
CI-PI-1		Futurecasting-CI functionality and performance significantly beyond that required to support current use scenarios shall be provide
CI-PI-2		Upgradeability-the CI shall accommodate software and hardware evolution
CI-PI-3		Scalability-the CI architecture shall be scalable to accommodate a wide range of actors, resources, and services

ID		Requirements
CI-PI-4		Extensibility-the CI architecture and components shall be extensible so that new services and/or resources can be added, and existing services and/or resources can be augmented, throughout the lifetime of the OOI
CI-PI-5		Reliability-Resources, services, and the CI architecture shall be fault-tolerant
CI-PI-6		Interoperability-the CI shall be interoperable with cooperating systems inside and outside the marine community that manage environmental data, especially IOOS and Neptune Canada
CI-PI-7		Availability-the CI shall be available on a 24/7/365 basis with no more than 1% downtime
CI-PI-8		Serviceability-the CI shall facilitate debugging and root cause analysis
CI-PI-9		Usability-the CI shall make all user interfaces human friendly and web-accessible
CI-PI-10		Accessibility - public access for data from all core sensors shall be available: all information is open by default. The CI shall limit proprietary periods to one year for non-core sensors: all data will be publicly accessible after the expiration of a proprietary period
Cost Effectiveness		
CI-CE-1	TL	The CI shall be designed to minimize the cost over its (25 year) lifetime
CI-CE-2	TL	To the extent possible CI shall utilize the common hardware and software interfaces with other observatory elements

3.2 Cyberinfrastructure (CI) Operating Infrastructure

ID		Requirements
Communications (OC)		
CI-OC-1	TL	The CI shall provide a real time (i.e., minimum delay) communication capability
CI-OC-2		The CI shall provide a once and only once guaranteed delivery (i.e., in situ caching pending acknowledgment of receipt) communication capability
CI-OC-3		The CI shall provide a store until requested (i.e., pull mode) communication capability
CI-OC-4		The CI shall provide a streaming media (either asynchronous or continuous) communication capability
CI-OC-5		The CI shall provide a topic-based (e.g., register to receive) communication capability
CI-OC-6		The CI shall facilitate peer-to-peer communication between discoverable resources
CI-OC-7		The CI shall provide secure communication protocols
CI-OC-8		The CI shall facilitate communication in the presence of high/low available bandwidth, low/high channel latency and periodic/on-demand connection
CI-OC-9		The CI shall facilitate the accurate (at least 0.99999) delivery of messages
CI-OC-10		The CI shall provide a documented communication interface
CI-OC-11		Message formats handled by the CI shall utilize a specified structure
CI-OC-12		The headers of messages handled by the CI shall have a specified content
CI-OC-13		The CI shall time-stamp message headers synoptically with an accuracy of 1 ms upon receipt
CI-OC-14		All messages handled by the CI shall be checked for hostile content

ID		Requirements
Mediation (OM)		
CI-OM-1		The CI shall facilitate mapping between senders and receivers with different vocabularies
CI-OM-2		The CI shall specify and support a local vocabulary
CI-OM-3		The CI shall facilitate a data model for resources based on characterization of meaning (semantics)
CI-OM-4		The CI shall facilitate a data model for resources based on characterization of structure (syntax)
CI-OM-5		The CI shall facilitate a vocabulary for data model characterization
Governance Security (OS)		
CI-OS-1	TL	The national security concerns of the OOI's sponsoring government shall be accommodated
CI-OS-2	TL	All resources connected to an OOI observatory shall be authorized and authenticated
CI-OS-3		All observatory actors shall be authorized and authenticated
CI-OS-4		All observatory resources and services shall be auditable
CI-OS-5		Different levels of access to resources shall be provided for actors with different levels of authorization
CI-OS-6		Access privileges for resources and their associated metadata may be different
CI-OS-7		The CI shall enforce OOI resource security and access policies independent of membership in the OOI observatories
CI-OS-8		Transport and message level security, authorization and authentication shall be provided
CI-OS-9		Application level security services shall be provided
Governance Policy Framework (OP)		
CI-OP-1	TL	All resources connected to an OOI observatory shall be identifiable, authenticatable, authorizable and auditable
CI-OP-2		Moved to II-3
CI-OP-3		A policy-based decision support system for resource management shall be devised
CI-OP-4		External interfaces to any OOI observatory shall conform with all applicable legal requirements and OOI policies
CI-OP-5		OOI resource rights and allocation policies shall be established and enforced

3.3 Cyberinfrastructure (CI) Services Infrastructure

ID		Requirements
Identity Management (II)		
CI-II-1		The CI shall verify and validate the identity of all resources connected to any OOI observatory
CI-II-2		The CI shall verify and validate the identity of all observatory actors
CI-II-3		The CI shall support identity federation

ID		Requirements
Policy Management (IP)		
CI-IP-1	TL	The CI shall implement policy-based governance for resource access and utilization
CI-IP-2		The CI shall trace resource utilization to the initiating actor
CI-IP-3		Utilization of a resource shall be governed by the rights and allocations of the initiating actor
CI-IP-4		The CI shall implement fault recovery policies
Resource Management – Characterization (IRC)		
CI-IRC-1	TL	OOI standard metadata shall meet or exceed national standards
CI-IRC-2		OOI standard metadata shall include as applicable, but not necessarily be limited to, a complete description of behaviors, content, syntax, semantics, provenance, quality, context, citation, correspondence and governing policies
CI-IRC-3		OOI metadata shall utilize a specified vocabulary
CI-IRC-4		The relationship between OOI standard metadata and the vocabulary shall be maintained
CI-IRC-5		OOI standard metadata shall be bound to all resources from inception to destruction
CI-IRC-6		Data-generating resources shall either provide OOI standard metadata or a means by which their metadata can be transformed to OOI standard metadata
CI-IRC-7		Data generating resources using proprietary formats shall provide a means by which their data can be transformed to OOI standard formats
CI-IRC-8		Data-product generating resources shall provide a statement of provenance/lineage that associates the input, resultant, and generating resources
CI-IRC-9		Data-modifying resources shall maintain ORION standard metadata
CI-IRC-10		The CI shall facilitate third party metadata enrichment throughout the life cycle of a resource
CI-IRC-11		The CI shall verify compliance of metadata with the OOI standard
CI-IRC-12		The CI shall automatically manage metadata to the maximum extent possible
Resource Management – Discovery (IRD)		
CI-IRD-1	TL	All resources connected to an OOI observatory shall be discoverable by the CI either directly, by content or through their associated metadata
CI-IRD-2		Resource discovery shall operate in the presence of mixed vocabularies
CI-IRD-3		The CI shall provide catalogs of distributed resources
CI-IRD-4		OOI catalogs shall have the capability of federating
CI-IRD-5		A participating catalog shall present the aggregate holdings of the federation
CI-IRD-6		Resource catalogs shall be maintained automatically
CI-IRD-7		The CI shall describe how to access available resources and metadata
CI-IRD-8		Resource discovery services indexed by community-specified criteria such as, but not necessarily limited to, geographic position, temporal interval, and measurement type shall be provided
CI-IRD-9		Seamless resource discovery with affiliated systems shall be facilitated

ID		Requirements
CI-IRD-10		Discovery services that support physical samples, including biological, chemical, and geological types, shall be provided
CI-IRD-11		Multiple actors shall be able to discover the same resource simultaneously
CI-IRD-12		The CI shall integrate resource discovery with resource access
Resource Management – Notification/Publications/Subscription (IRP)		
CI-IRP-1		The CI shall provide registration services for resource notification
CI-IRP-2		The CI shall provide services that automatically register resources for notification to the observatory operator
CI-IRP-3		The CI shall provide notification of resource state change
CI-IRP-4		Applications and resources shall define publication topics using ORION standard protocols
CI-IRP-5		The CI shall provide services to publish data from non-ORION sources
CI-IRP-6		Applications and resources shall define their subscriptions using ORION standard protocols
CI-IRP-7		The CI shall provide services to subscribe to data from non-ORION sources
Resource Management-Persistence (IRE)		
CI-IRE-1		All data produced on an OOI observatory shall be archivable
CI-IRE-2		Data categories with different categories of guaranteed permanence shall be established
CI-IRE-3		The CI shall implement capabilities to ensure that archived data are accurate
CI-IRE-4		The CI shall maintain archived data so that they are up-to-date
CI-IRE-5		Archived data that are stored offline shall remain discoverable online
CI-IRE-6		Archived data that are stored offline shall remain publishable online with a specified delay
CI-IRE-7		OOI data archives shall subscribe to evolving data versions
CI-IRE-8		OOI data archives shall subscribe to user-provided data products that meet OOI standards
CI-IRE-9		OOI data archives shall ingest and correct out of time sequence data
CI-IRE-10		OOI data archives shall flag data with duplicate timestamps
CI-IRE-11		The CI shall provide services for automatic initial data QA/QC
CI-IRE-12		The CI shall support delayed mode QA/QC by resource providers
Resource Management-Top Level Resource Utilization		
CI-IRU-1	TL	The CI shall provide a standard mechanism to manage stateful resources
CI-IRU-2		The CI shall facilitate the capability for resources to initiate change
CI-IRU-3		The CI shall provide the capability for resources to act on behalf of other resources in an auditable manner
CI-IRU-4		The CI shall schedule, prioritize and control physical resources (based on policy)
CI-IRU-5		The CI shall monitor resource status throughout OOI observatories
CI-IRU-6		The CI shall log resource status

ID		Requirements
CI-IRU-7		The CI shall facilitate interaction with distributed resources from any compatible networked location
CI-IRU-8		The CI shall provide services to group resources
CI-IRU-9		The CI shall provide for simultaneous interaction with resource groups
CI-IRU-10		The CI shall characterize its state
CI-IRU-11		The CI shall manage allocated resources in a manner consistent with their allocations
CI-IRU-12		Resources shall provide OOI standard monitoring and control interfaces
CI-IRU-13		The CI shall automatically detect and manage the attachment/detachment of physical resources
CI-IRU-14		Multiple actors shall be able to access the same resource simultaneously according to their privileges
CI-IRU-15		The observatory operator shall have control with specified functionality over all physical resources
Resource Management-Process		
CI-IRW-1	TL	The CI shall provide tools to compose (configure, compile, verify, save, and execute) processes
CI-IRW-2		The CI shall provide services to link multiple processes
CI-IRW-3		Process composition shall be possible when offline (not connected to the Internet)
CI-IRW-4		The CI shall provide services to automatically monitor, schedule and control instantiated processes
CI-IRW-5		The CI shall provide actors with estimated performance/turnaround for instantiated processes
CI-IRW-6		The CI shall provide capabilities to assess the status of instantiated processes
CI-IRW-7		The CI shall provide services to access and modify instantiated processes
CI-IRW-8		Merged into OS-4
Resource Collaboration Management (IS)		
CI-IS-1		The CI shall identify resources (local, distributed, or external) as needed to perform collaborative tasks
CI-IS-2		The CI shall provide a standard interface to OOI resource collaboration services

3.4 Coastal/Global Scale Nodes (CGSN)

ID		Requirements
General (G)		
CGSN-G-1		The CGSN shall provide a complete observing system providing both a real-time bi-directional link between users on the Internet anywhere in the world and a wide variety of current and next generation instruments and delivery following instrument recovery of calibrated, original sampling rate data from a wide variety of current and next generation instruments through the CI
CGSN-G-2		The CGSN shall include a combination of fixed, moored and mobile observing platforms and infrastructure, in-situ and cabled power supplies; a communications network providing high bandwidth communications from surface expressions and in the water acoustic and cabled communications to underwater instrumentation; functional control of accessible infrastructure components; and some level of control over instruments in the observatory network
CGSN-G-3		The CGSN shall be designed to be expandable, so that additional science nodes, instruments, and sensors can be readily connected to the system at a future date
CGSN-G-4		The CGSN shall support observations across the full depth of the water column, from the sea surface to the sea floor at each of its nodes.
CGSN-G-5		The CGSN will use mobile assets (gliders, AUVs) to sample in space and time to complement the time series and fixed array sampling of the moorings.
CGSN-G-6		The CGSN shall include Coastal Nodes (a long-term Endurance Array in the Pacific Northwest, a relocatable Pioneer Array array initially located in the Mid-Atlantic Bight) and Global Nodes.
CGSN-G-7		The CGSN nodes shall support the multidisciplinary core sensor packages identified for deployment on its fixed and mobile platforms.
CGSN-G-8		The CGSN nodes shall provide extra power and bandwidth beyond that need by the core sensor packages in order to provide the capability of hosting additional instruments and sensors provided by individual PIs or by groups of PIs.
CGSN-G-9		The CGSN shall be designed for an operational life of at least 25 years
CGSN-G-10		The CGSN shall be designed with commonality across Coastal and Global Nodes in order to minimize life cycle costs over the 25 year design life
CGSN-G-11		The CGSN power and communication systems shall be designed to be upgradeable over the life of the system
Power Network (PN)		
CGSN-PN-1		The CGSN shall provide in collaboration with the RSN a power network capable of delivering XX (10?) kW of power to each science node at the elements of the Endurance Array attached to the RSN.
CGSN-PN-2		Power provided by the RSN to the Endurance Array shall be provided to users at 375/400VDC and 48VDC
CGSN-PN-3		Power will be provided by storage batteries in absence of connection to the RSN cable (elements of the Endurance Array) or to surface moorings with on board power generation (Pioneer, Endurance, Global).
CGSN-PN-4		Power generation for uncabled elements shall at some locations be provided by surface moorings with on board power generation; such moorings shall initially provide 50 W continuous duty power. Capability to provide 500 W to 1 kW at select surface moorings shall be a goal of the CGSN IO.

ID		Requirements
CGSN-PN-5		Provisions to allocate power delivery resources to the various instruments and platforms shall be provided through the CI
CGSN-PN-6		Power will be provided to recharge AUVs at select docking stations in the Pioneer Array.
CGSN-PN-7		The CGSN power network shall be designed to have electrical noise levels that do not prevent oceanographic sensors making low signal level measurements.
CGSN-PN-8		The CGSN power generation systems shall be designed not to interfere with either atmospheric observations on surface platforms or with oceanographic measurements.
Data Communications Network (CN)		
CGSN-CN-1		A communications network shall be provided interconnecting instruments with each other, with shore stations, and with users and operators via the Internet.
CGSN-CN-2		A communications network shall be provided with the capability to ingest delayed mode data from instruments not connected to the network in real time, providing higher sampling rate data from internal data storage or having yielded revised versions of data following calibration and quality control procedures. This network shall be integrated with the CI through interfaces and shared resources.
CGSN-CN-3		The communication network shall be designed with the view of upgrading and expanding capabilities
CGSN-CN-4		Provisions for assigning and prioritizing Quality of Service shall be provided
Resource Time Distribution (TD)		
CGSN-TD-1		The CGSN shall provide instruments connected in real time with a mechanism to time stamp data samples with a date including year, day, hour, minute and second and fraction of a second with a resolution and accuracy of at least 10 s. The reference for the time stamp shall be UTC-USNO as provided by the Global Positioning System as provided through the CI or by other direct to GPS routes.
CGSN-TD-2		The CGSN shall establish protocols to time stamp and assess timing accuracies of internally recording instruments.
Observatory Control (OC)		
CGSN-OC-1		The CGSN shall provide reliable control of both the infrastructure and all instruments in the CGSN network
CGSN-OC-2		The CGSN shall provide for measuring, logging and accessing engineering data defining the system state and power and communication bandwidth utilization
CGSN-OC-3		The CGSN shall be designed to allow power and communication bandwidth to be dynamically-directed where science needs and priorities dictate
CGSN-OC-4		The CGSN shall be capable of detecting and isolating a faulted instrument with no permanent damage to other instruments. The CGSN shall ensure that mechanical or electrical failure of a single instrument does not put the node at risk.
CGSN-OC-5		The CGSN shall ensure that mechanical or electrical failure of a single instrument does not put the node at risk

ID		Requirements
CGSN-OC-6		Shut down of the system or individual instruments shall be in an orderly and defined manner to the greatest extent possible. Exceptions to this requirement e.g., a cable fault to ground, mooring failure, vandalism, shall be identified and have protocols for response and alerting.
CGSN-OC-7		The CGSN IO shall provide schedules for delivery to that IO of additional instruments and sensors to be deployed.
CGSN-OC-8		The CGSN IO shall coordinate with JOI to develop service schedules and cruise schedules for the initial installation and subsequent recovery and redeployments of fixed and mobile assets; schedules should be developed with a five year forward look.
CGSN-OC-9		The payloads for the CGSN nodes shall be determined one year prior to deployment to support preparations, including testing and burn in.
Data Quality Control and Calibration		
CGSN-DQCC-1		The CGSN IO shall be responsible for pre-deployment, operational, and post-deployment procedures to ensure the quality of the data as part of the CI integrated system.
CGSN-DQCC-2		The CGSN IO shall calibrate or have calibrated all sensors prior to deployment and after recovery; it shall maintain records of calibrations and associated metadata and have those records accessible together with the data as part of the CI integrated system.
CGSN-DQCC-3		The CGSN IO shall integrate quality control procedures to be applied to the data in the network in real / near-real time as part of the CI integrated system.
CGSN-DQCC-4		The CGSN IO shall monitor data from its nodes in real time, post and pass on to the CI IO data quality and data outage alerts.
Resource Science Instrument Interface (SII)		
CGSN-SII-1		The physical instrument interface to the CGSN for instrumentation directly connected to power/signal cable shall be a single science electrical wet-mateable connector.
CGSN-SII-3		The direct wired node science instrument interface shall provide each science connector with: a) An IEEE 802.3 100baseT Ethernet data connection b) power
CGSN-SII-4		The acoustically linked interface to the CGSN shall be provide by acoustic modem hardware provided by the IO on the node side and specified or provided by the IO on the sensor/instrument side.
CGSN-SII-5		Specs on what the acoustic link provides
CGSN-SII-6		Each science connector' power and communications capacity shall be expandable using one or more secondary interfaces to allow each science connector to interface to many (>10) instruments
CGSN-SII-7		Provisions shall be provided to support instruments using RS-232 and RS422 serial protocols and 12 VDC power
Security (S)		
CGSN-S-1		The CGSN shall be designed and installed to ensure the security of the system from natural and man-made hazards through the use of (but not necessarily limited to) community-standard mooring, glider and AUV practices .

ID		Requirements
CGSN-S-2		The shore facilities will have physical security measures to monitor and protect the network and power equipment and inventories
CGSN-S-3		The surface buoys of the CGSN moorings will have satellite transmitters to allow them to be tracked in case of theft.
Community Instruments/Experiments (CIE)		
CGSN-CIE-1		While community instruments may be provided as part of the infrastructure of a coastal and global scale observatory, no community instruments or permanent time series data acquisition experiments are required for the operation of the CGSN.
Operations (O)		
CGSN-O-1		The CGSN shall be designed so that UNOLS research vessels will be able to perform anticipated maintenance and operational procedures to the greatest extent possible. Exceptions to this requirement shall be identified e.g. initial deployment of the EDP
CGSN-O-2		One or more portable node simulators capable of emulating the node science instrument interface shall be available to users to facilitate instrument development.
CGSN-O-3		A complete node simulator with wet test capability shall be provided at a CGSN staging area. This simulator shall allow an instrument to be connected in a seawater environment in order to validate to the greatest extent possible, an instrument's readiness for deployment on a CGSN science node.
Reliability (R)		
CGSN-R-1		CGSN shall monitor performance in real time and maintain a watch against platform and/or instrument and sensor failures and degradation
CGSN-R-2		CGSN shall include in its practices pre-deployment burn-in and testing to support high reliability
CGSN-R-3		CGSN practice on spares and human resources shall be geared to minimize data loss by mounting service efforts to recover and/or to replace lost or degraded hardware.
CGSN-R-4		CGSN shall conduct analyses of any platform, sensor or instrument failure and degradation, shall monitor failures to alert for patterns and potential failures, shall keep histories for major components, instruments, and sensors.
CGSN-R-5		CGSN shall keep apprised of improvements to materials and methods as they apply to platforms and sensors and shall consider upgrades in these tat increase reliability.
Environment (E)		
CGSN-E-1		The CGSN nodes shall be designed for their environments: Endurance for the coastal waters of the Pacific Northwest, Pioneer for the continental shelf of the mid-Atlantic Bight, and Global for the selected high latitude and mid-Atlantic sites; the design process will employ environmental data (wind, waves, currents, bottom type) from the specific sites
CGSN-E-2		The CGSN nodes shall be capable of operating for periods up to 20% longer than planned turn-around times (6 months for some coastal elements; 12 months for global) in recognition of possible weather delays to planned servicing

ID		Requirements
CGSN-E-3		CGSN infrastructure shall be designed to minimize failures due to biofouling, corrosion, cyclic fatigue, commercial ship traffic, fishing.
CGSN-E-4		CGSN instruments and sensors shall be designed to mitigate data quality degradation and loss associated with biofouling.

3.5 Regional Scale Nodes (RSN)

ID		Requirements
General (G)		
RSN-G-1		The RSN shall include a power network delivering power to all instruments and infrastructure; a communications network providing high bandwidth communications to all instruments and infrastructure; functional control of all infrastructure components; and time distribution
RSN-G-2		The RSN shall be designed to be expandable, so that additional infrastructure and sensors can be readily connected to the system at a future date
RSN-G-3		The RSN infrastructure shall be designed to use electrical wet-mateable connectors accessible by academic class remotely operated vehicles (ROVs) e.g., Ventana, Jason II and ROPOS to enable system maintenance and expansion.
RSN-G-4		The RSN infrastructure shall support individual instruments or clusters of instruments at locations up to 40km around Primary and Secondary Nodes. Remote sites may have reduced power, communications bandwidth and reliability
RSN-G-5		The RSN shall be designed for an operational life of at least 25 years
RSN-G-6		The RSN shall be designed to minimize life cycle costs over the 25 year design life
RSN-G-7		The RSN power and communication network shall be designed to be upgradeable over the life of the system
Power Network (PN)		
RSN-PN-1		The RSN shall provide a power network capable of delivering 10kW of power to each Primary or Secondary Node and their attached secondary infrastructure. Each backbone cable to the Shore Station capable of delivering a total of 40kW of power.
RSN-PN-2		Provisions to allocate power delivery resources to the various infrastructure ports shall be provided
RSN-PN-3		The RSN power network shall be designed to have electrical noise levels that do not prevent oceanographic sensors making low signal level measurements.
Data Communication Network (CN)		
RSN-CN-1		A communications network shall be provided to connect all instruments to their attached shore station, and with users and operators via the CyberInfrastructure
RSN-CN-2		The communication network shall provide an aggregate data rate of at least 1 Gb/s (goal 10Gb/s) from each Primary Node in the system
RSN-CN-3		Latency of interactions between the shore facility and an instrument on any node in the system shall be less than 0.1 seconds

ID		Requirements
Resource Time Distribution (TD)		
RSN-TD-1		The RSN shall provide instruments with a mechanism to time stamp data samples with a date including year, day, hour, minute and second and fraction of a second with a resolution and local accuracy for each site around a Primary or Secondary Node of at least 10 µs through the CI.
RSN-TD-2		The absolute accuracy of the timestamp mechanism will be at least 1 ms referenced to UTC-USNO as provided by the Global Positioning System.
Observatory Control (OC)		
RSN-OC-1		The RSN shall provide reliable control of both the power and communication infrastructure on the RSN network
RSN-OC-2		The RSN shall provide for measuring, logging and accessing engineering data defining the system state and power and communication bandwidth utilization
RSN-OC-3		The RSN shall be designed to deliver power where science needs and priorities dictate
RSN-OC-4		The RSN shall be capable of detecting and isolating electrically faulted instruments with no permanent damage to other instruments. The fault isolation process shall be less than 5 minutes during which time power and data services to other nearby instruments may be affected
RSN-OC-5		The RSN shall be capable of detecting and isolating faulted infrastructure with no permanent damage to other infrastructure or instruments. The fault isolation process will be automatic and take less than 5 minutes but the fault identification, resolution and system restart may need human intervention with an initial response time less than 30 minutes.
RSN-OC-6		Shut down of the system or individual instruments shall be in an orderly and defined manner to the greatest extent possible. Exceptions to this requirement e.g., a cable fault to ground, shall be identified
Instrument Interface (II)		
RSN-II-1		The RSN Junction Boxes shall provide up to 8 ports to connect to science instruments via dry mate or ROV mateable connectors
RSN-II-2		The Junction Box instrument interface shall provide each connector with preconfigured hardware interfaces and protocols appropriate for each sensor, including RS232, RS485, RS422 and Ethernet 10/100baseT.
RSN-II-3		Power shall be provided to sensors connected to the Junction Boxes with preconfigured Voltages appropriate for each sensor, between 12 and 48 volts.
Security (S)		
RSN-S-1		The RSN shall be designed and installed to reduce the risk to the security of the system from natural and man-made hazards through the use of (but not necessarily limited to) industry-standard cable burial practices and the use of trawl-resistant design practices for all seafloor infrastructure installed in waters that are fished.
RSN-S-2		The Shore Stations and Backhaul Huts will have physical security measures to monitor and protect the network and power equipment

ID		Requirements
Operations (O)		
RSN-O-1		The RSN shall be designed so that the R/V Thomas Thompson or similar UNOLS research vessel will be able to perform anticipated maintenance and operational procedures to the greatest extent possible. Exceptions to this requirement shall be identified e.g., heavy lift operations that exceed the capabilities of the vessel or ROV
RSN-O-2		One or more portable node simulators capable of emulating the instrument interface shall be available to users to facilitate instrument development.
RSN-O-3		A complete node simulator with wet test capability shall be provided at the RSN staging area. This simulator shall allow an instrument to be connected in a seawater environment in order to validate to the greatest extent possible, an instrument's readiness for deployment on a RSN science node.
Reliability (R)		
RSN-R-1		There is a 95% probability that the maximum cumulative amount of time in one year that an instrument connected the RSN will be unavailable due to infrastructure failures shall be 3 days.
RSN-R-2		There is a 95% probability that the maximum cumulative amount of time in one year that an instrument connected directly to one of the RSN science ports will be unavailable due to planned maintenance shall be 10 days.
Environment (E)		
RSN-E-1		The RSN nodes shall be designed for a depth of 3,000m
RSN-E-2		Node must be capable of functioning in water with 0.25m sand loading