Has the project team adequately described and prioritized the high level quantitative science requirements that motivate and flow down to the overall infrastructure design?

- >15 years of community planning led to creation of the OOI Science Plan.
- To advance our understanding of ocean and Earth processes, and their interactions, we need:
  - a continuous, interactive presence in the oceans with high temporal resolution, especially to observe episodic events or dynamic systems with small scale components whose characteristics change over time periods longer than a few months,
  - infrastructure enabling investigation at the time and length scale(s) of relevance to the science questions under study, including high vertical resolution from the sea surface to the sea floor,
  - adaptive sampling, allowing targeted science campaigns in response to detected episodic events, and
  - the payload capacity to field diverse, multidisciplinary sensing systems.
- OOI High Level Requirements:
  - Interoperability
  - Expandability
  - Upgradeability
  - Life Cycle Cost Effectiveness
  - Occupy sites for up to 25 Years
  - Open Designs
  - User Support Services
  - Event Detection & Adaptive sampling
- CSO High Level Requirements:
  - Modularity
  - Multiple configurations:
    - Permanent “Endurance array”
    - Relocatable “Pioneer array”
  - Reconfigurable
  - Customizable
  - Provide two-way communication and real-time data telemetry from sites along the coastal US; and, where required by Science User Requirements (SUR), provide power to a seafloor junction box.
- CoOP Workshop identified areas of scientific interest and advances in research which could be furthered by coastal observing systems.
- CORA Workshop provided an overall vision for the design of coastal observatories including the need for Endurance and Pioneer arrays.
- RFA process used to identify node locations for multidisciplinary and high priority science.
- D&I Workshop helped prioritize the types of infrastructure and explore candidate installation locations.
- CND captured highest priority science within budget constraints.
- SUR shows the science requirements and the requirement flow-down from numerous reports and workshops.

Are OOI research objectives well linked to science user requirements? Are these user requirements met by the proposed network design?

- OOI research objectives are closely linked to SURs.
- OOI research objectives were derived from extensive community involvement.
- SURs were derived from OOI research objectives.
  - SURs derived from CoOP, CORA, and D&I Workshops, as well as RFA process.
  - CND satisfies all high level CSO science user requirements
  - Individual SUR satisfaction will depend on final design.

**Is the description of infrastructure needed to meet OOI's science objectives adequate, including the system-level design and definition of functional requirements?**

- Need for RCO, CSO, GSO observatories, and CI element are well-justified through community workshops, as well as NAS and NSF reports as summarized in the OOI science plan.
- Infrastructure needs and quantitative functional requirements are highly-dependent on site selection.
- Qualitative functional requirements included in the SUR compendium (modular, reconfigurable, etc.)
- System-level design initiated with CoOP and CORA reports, and matured through RFA process and D&I Workshop

**Has an appropriate schedule for implementation been developed for each of the three scales of the OOI?**

- The PEP (Appendix 4) explains the approach to the critical path. The funding profile and the need to fit the RCO into that profile controls the overall schedule. CSO and GSO implementations are fit in around the RCO.

**Are cost estimates for infrastructure at each of the OOI scales well justified and do they encompass all aspects of implementation?**

- Cost estimates are organized and reported by WBS.
- Budget contingency is managed by Project Office.
- Cost estimates include core instruments.
- Cost estimates were developed for each of the coastal system sites and includes costs for hard goods, labor, installation and annual maintenance.
  - Capital costs estimated from hardware lists using published prices or industry cost analogies. Hardware includes cables, moorings, subsurface mooring hardware, profilers, etc.
  - Labor costs estimated from experience form similar systems using standard salary rates.
  - Installation costs estimates from experience and includes crew, mobilization/demobilization, global or intermediate class vessels depending on site location and activities.
  - Annual operations and maintenance costs includes operations staff, shore facility support, and spares
- Cost estimate details are summarized in Excel tables.
Are there lingering elements of the OOI network that require further engineering development and has a research and development plan been proposed that provides a roadmap to complete these efforts to ensure all elements of the system will be ready for deployment?

- The CSO will employ novel engineering designs to produce modular and reconfigurable fixed (Endurance) and relocatable (Pioneer) arrays
  - This will involve new engineering designs and processes.
  - Relocation of Pioneer arrays will be determined through a peer-reviewed proposal process and will require procedures for refurbishment and reinstallation.
- The CSO will possibly require R&D to interface with cables run from shore to provide high power and bandwidth.
  - OOI experience with the RCO should minimize this R&D issue
- The CSO IO will identify any specific R&D needs and provide a plan for appropriate development and testing.
- The IO will provide an engineering risk assessment of expected additional funds required should the technology schedule slip.
- NDBC buoy system, CMAN network, and NWLON Program lessons learned will be leveraged, as will those of Long-term Ecosystem Observatory (LEO), Martha’s Vineyard Coastal Observatory (MVO), Duck, NC, Gulf of Maine Ocean Observing System (GoMoOS), Southeastern US Atlantic Coastal Ocean Observing System (SEA-COOS), Monterey Bay Ocean Observing System (MOOS), Santa Barbara Channel – Santa Maria Basin Circulation Study, Gulf of Alaska: SALMON, and San Diego Coastal Ocean Observing System (SDCOOS).

- Sensor technology may require R&D to handle the long-term, in-situ measurements that the OOI will enable.
- Sensors will not delay the deployment of the OOI; the sensors will be deployed when they have necessary capability.
- R&D for sensors will be accomplished via a three-pronged approach:
  - In collaboration with sensor suppliers
  - By individual PI's
  - For core sensors, by the responsible IO as designated in interface agreements.
- Types of capabilities that sensors will require:
  - Reliability
  - Non-cascading failure modes
  - Low power consumption
  - Ability to hold calibration or self-calibrate
  - Survivability in severe environments
  - Resistance to or methods to mitigate bio-fouling
  - Non-attended operation
  - Interfaces to Cyberinfrastructure.
- An OOI-wide instrument qualification and acceptance process is envisioned.

- Enhanced mobile platform technologies, including AUV's, gliders, and drifters, may require additional R&D in order to provide a reliable docking system and appropriate endurance. The OOI infrastructure is being designed to provide power and data services to such docking systems should they be developed, however docking systems will not delay deployment of the OOI.

- There is a strong community desire for a standardized instrument interface across platforms. R&D efforts are likely required to facilitate development of a standard instrument interface. OOI will leverage the experiences of the MBARI "smart network" sensor puck, NEPTUNE SIIM, and ROADNet project during the interface definition process.
Are the project staffing levels for each Implementing Organization (IO) adequate to complete the tasks required to complete the network designs and implement them? (This information will be preliminary as the proposals for the CSO IO will not have been received.)

- Preliminary information on IO management is in the Project Execution Plan, section 3.5; pg. 14.