Evolving the SURA Distributed Coastal Laboratory (DCL)

Some background notes to initiate discussions by the CRC Steering Group

The Concept

The SURA Coastal Research Committee (CRC) has embraced the concept of creating a *Distributed Coastal Laboratory* (DCL; for elaboration see white paper distributed to Coastal Research Committee in April 2007) to support research and engineering studies on multi-faceted coastal processes, promote public education and outreach on the importance of coastal phenomena, and facilitate numerous practical applications (including national security). A resolution supporting the promotion of the DCL was endorsed by the full SURA Board of Trustees at their meeting Miami on April 18, 2007. The vision will be enabled by a robust information technology (IT) infrastructure that links existing resources, owned and operated by a variety of stakeholders, into a whole that is greater than the sum of its parts. It is intended to become the coastal sciences substantiation of a service-oriented architecture (SOA).

The Distributed Coastal Laboratory will enable information from multiple observatories, observing platforms (i.e. those operated by NOAA, NASA, ONR, USGS, the private sector or universities), and numerical model outputs to be integrated and made widely accessible in standardized formats that allow phenomena operating on spatial scales of thousands of kilometers to be described and understood. Doing this successfully falls jointly within the domains of information technology (IT) and cutting edge interdisciplinary coastal science. SURA and its member institutions possess exceptional capability in both domains. The (virtual) distributed laboratory will involve a network of data systems, forecast models, and supercomputers geographically distributed throughout the country. These system components will interact across standardized interfaces in ways analogous to the World Wide Web and will be networked to provide redundancy and reliability. The "Distributed Coastal Laboratory" that SURA envisions will be a national asset that provides timely, high quality information on the shelf, coastal and estuarine realms of the entire U.S. Eastern Seaboard and Gulf of Mexico. One system should serve researchers, providers and a variety of end users. The science and engineering goals for spatially-distributed coastal information should be to:

- enable identification of spatial scales of coherence of important physical, biological, and biogeochemical ocean and coastal phenomena;
- provide reliable, synchronized and standardized time series of important physical, biological, and biogeochemical ocean and coastal phenomena at spatially distributed sites over the U.S continental shelves and from the deep sea;
- conform to a uniform and accepted set of standards for resolution and data accuracy against which new technologies can be evaluated.

Some candidate science themes for the DCL

The existing SURA Coastal Ocean Observing and Predicting Program (SCOOP) has, for the past few years, been advancing a prototype distributed facility that engages multiple universities and disciplines to create a cyberinfrastructure for coastal research and applications, focused on predicting and analyzing coastal hazards, hurricane impacts and coastal inundation. The Service Oriented Architecture (SOA) that is being developed to serve the inundation-specific needs of SCOOP can be expanded to serve the broader needs of coastal science community at large. Economies can be gained by having a single SOA serve intersecting science themes as illustrated conceptually in Figure 1. An early goal of the CRC Steering Group should involve identification of a few compelling and important science themes to add to SCOOP in evolving the DCL. To launch discussions, we may take some cues from coastal Louisiana where socioeconomic urgency is attached to three strongly intersecting coastal issues: (1) coastal inundation, (2) coastal land loss, and (3) continental shelf hypoxia. The existing SCOOP program is already helping to address the first issue. In order to come to grips with issues (2) and (3), we must first gain improved capabilities in assessing and modeling river hydrology (including nutrient and sediment loads) and shelf circulation (barotropic and baroclinic). There is probably no better test bed than Louisiana for demonstrating the relevance and strength of the DCL concept by providing a SOA for distributing and integrating information relevant to inundation, coastal land loss, river hydrology, shelf circulation, and water quality (hypoxia).

The link between Coastal Circulation (possible Theme II in the DCL) and Oxygen Dynamics (possible Theme III in DCL) is explicit in the oxygen balance equation. In simple terms, hypoxic conditions arise because the consumption of oxygen exceeds the import or production of "new" oxygenated water. Circulation not only distributes nutrients over the shelf, but also causes horizontal advection of oxygenated water along and across the shelf and determines vertical mixing of oxygen downward from the surface layer. Horizontal advection and mixing may reflect contributions from tides, wind stress, large-scale eddies or topographically trapped shelf waves. Relatively advanced three dimensional models are required to adequately account for these contributions. River hydrology is a key factor in determining the input of excess nutrients and is also the key source of the buoyancy that stratifies the water column and impedes the vertical mixing as well as a source of sediments for alleviating coastal land loss. River hydrology is thus a possible candidate for another theme (Theme IV?).

To adequately consider all of the complex contributors to hypoxia, a new and advanced suite of open source community models is urgently needed. These models will include physical models (via Theme II) as well as biogeochemical models and ecological models. The DCL can provide the essential SOA for enabling the effective coupling of trans-disciplinary models. factors such as nutrient fluxes are important and may bring about the need for a fourth theme focused on river hydrology (with links to USGS), a theme that is also relevant inundation and SCOOP. The point is that there are multiple intersections that a DCL can facilitate and thereby serve all sub disciplines within the coastal community.

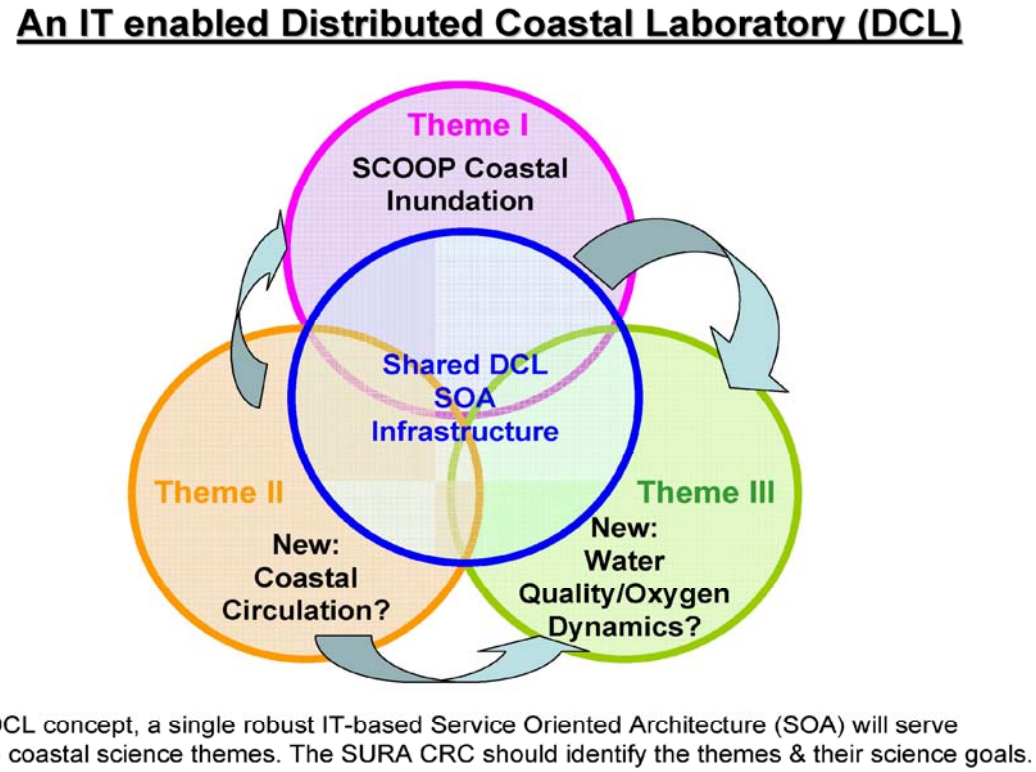

Figure 1. A simplified illustration of a single IT infrastructure serving multiple intersecting science themes.