RATIONALE FOR COASTAL OCEANOGRAPHY AND OCEAN OBSERVING SYSTEMS IN THE LOUISIANA IT-INITIATIVE

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The Need and Opportunity

With modest support from the IT-initiative, Louisiana State University and, therefore, the State of Louisiana, could be perfectly poised to assume a leadership role in a new and exciting regional (Delaware to Texas) program; the creation of an open-access network of distributed ocean sensors and linked computer models for the entire southeastern US coastal zone. This effort may serve as the nucleus to further develop and implement a national program. In our view, there are several good reasons why LSU should select the area of coastal oceanography and ocean observing systems as a broad area of enhancement under the IT-initiative: First, LSU has a long history of excellence in coastal research and could be perfectly positioned to move aggressively into the new high-tech area of ocean and remote observation systems; (2) with a modest investment now available to LSU through the IT-initiative, LSU and the State could rapidly realize the benefits of a regional/national ocean observing program; (3) the benefits associated with LSU assuming this leadership role would accrue in many of the categories identified by the Southern Governors' Association in its recent report, "New Economy"; and (4) Louisiana could profit immensely from this effort in terms of enhancing education, coastal stewardship, hazard mitigation and emergency preparedness. These reasons are elaborated on below.

A Coastal Heritage at LSU

Over almost a century, LSU has enjoyed an international reputation for leadership in the field of coastal research. This is not serendipitous in that Louisiana continues to rank very high with respect to environmental stresses, coastal and wetland losses and vulnerability to storms, hurricanes and other extreme events. Attempts to solve these problems have created significant opportunities and within the past decade or so, researchers in the Coastal Studies Institute have made significant strides in the area of *in situ* and remote coastal and oceanographic measurement, data assimilation and dissemination. Today, a solid foundation exists that will support infrastructure and technological expansion.

The National Context

Recently embraced by the Southeastern Universities Research Association (SURA), this new coastal initiative, referred to as the Southern Coastal Ocean Observing Program (SCOOP), will function when fully implemented as a single, tightly integrated laboratory, providing an unparalleled window to new scientific frontiers. In addition, it will host immediate socioeconomic issues and applications to the needs of industry. The laboratory will also provide a powerful tool for teaching and higher education in general. The initiative is clearly focused and supports the national agenda to establish an integrated, sustained ocean observing system for the US. Presented recently at the Southern Governors' Association meeting in Kentucky, the coastal initiative received resounding support by Governors of the Southern states. We propose that if the LSU ocean observing group is provided additional IT support, we would then be in a powerful position to play an important leadership role in guiding the design, implementation and sustained maintenance of the regional/national coastal initiative. As discussed in more detail below, benefits from this IT investment would be realized in attaining new levels of (1) research and competitiveness, (2) ocean observing technology, (3) approaches to teaching in the laboratory, and (4) better approaches to coastal stewardship and emergency management involving coastal and offshore emergencies for Louisiana.

Cutting Edge of Innovation in Ocean Observing at LSU

In conjunction with faculty from Computer Science and the Computer Center, researchers in the ocean observing group in CSI have developed a pilot system off the Louisiana coast in response to the needs of the State. The objective of this program, named WAVCIS (Wave-Current-Surge Information System) is to measure various ocean and meteorological phenomena (e.g., waves, currents, water level, winds) from numerous remote stations, communicate these data to a laboratory at LSU for processing prior to dissemination on a variety of web portals (http://wavcis.csi.lsu.edu). As part of this effort, real time satellite data acquired by CSI's Earth Scan Laboratory provide a comprehensive package of disseminated environmental information. While our *in*-situ and remote observing systems are advanced, we have identified several new areas that if supported by the IT-initiative, would move us to the forefront of this rapidly evolving technological field.

Oceanographic sensor development is required to facilitate more rapid transfer of larger volumes of data onshore. Recent advances in acoustic Doppler technology now permit a complete package of current and wave measurements from water depths in excess of two thousand feet. While we have recently made advances in post-processing of these data sets on-site and in making the data available in near real time, IT-initiative support would allow us to aggressively work towards solving connectivity problems and the use of fiber optic cable to enable "instrument-to-the-desktop" solutions. SURA has planned to deploy a fiber optic backbone along the coast of Virginia as part of a regional IT initiative. An investment of the Louisiana IT effort in ocean observing at LSU would likely result in SURA prioritizing Louisiana over other states for cable deployment. In turn this would expedite SURA's SCOOP initiative, and allow Louisiana to serve as a regional/national pilot project. Utilization of the backbone would not be restricted to ocean observing systems.

With respect to the remote sensing component of our effort, we would strengthen and broaden our capabilities in two main areas: use of RADARSAT SAR and high-resolution ocean color/sediment quantification. The recent acquisition of a high speed X-band antenna at the LSU Earth Scan Laboratory (funded by a Louisiana Technology Innovation Fund grant) provides new and technologically challenging opportunities to receive and apply, in real-time, satellite information to environmental problems of Louisiana and the region. Many of the newly launched satellite sensors provide essential information applicable to emergency response activities (i.e. mapping of flooded areas during storms/hurricanes, tracking of oil spills and harmful algal blooms, as examples), research and education at LSU and beyond. Only a handful of Universities in the U.S. have this new X-band technology and thus the opportunity exists, with adequate funding, to become national leaders in the application of remote sensing technology to the broad fields of coastal research and emergency response activities. The SAR data provide all-weather, day/night capabilities, a significant improvement over the passive remote sensing sensors that we currently process routinely, that cannot see through clouds. Our X-band antenna also gives us the potential to improve significantly on our detection and mapping of biological events in coastal regions using much higher resolution ocean color data from the Indian satellite Oceansat-1. The spatial resolution provided by the Oceansat OCM sensor is an order of magnitude better than the SeaWiFS data we currently acquire (with 1km pixels). We plan to develop new and innovative techniques for integrating the remote and *in-situ* coastal ocean observations. The satellite data yield a valuable spatial perspective on coastal/ocean processes that strengthens the usefulness and understanding of the coastal/ocean *in-situ* measurements. In turn, the *in-situ* measurements can provide essential "ground truth" data that enhance the usefulness of the satellite measurements, enabling the development of algorithms for quantification of those measurements.

In order to improve data flow, we would acquire hardware and telecommunication systems designed to capture, store, share, and utilize data gathered from remote stations and satellites. The complete solutions to these data gathering problems are not static and would include plans for growth. The data storage and communication options detailed here minimize costs and provide the opportunity to add capacity, as usage requirements become clear. These options also provide a way to make the collected data highly available, accessible, and recoverable.

The storage media and magnetic disks would be configured so that component failures do not harm the integrity of the collected data. Consolidated storage has always been easier to manage than decentralized storage. The recent availability of broadband communication networks makes centralized management of consolidated storage a practical possibility. High-speed networks make it possible to deliver data to widely dispersed locations from central locations. It is no longer necessary to attach storage to each computing device individually. Currently, distance remains important because bandwidth is not free although should approach a fixed cost in the future. The cost of managing collected data is sharply reduced when storage is consolidated and centrally managed.

Our goal is to deliver the needed storage capacity and related data management services without requiring a large capital investment in storage devices or commitment to the ongoing management of storage devices. At present, remote offshore stations use wireless communication to transmit data via communication satellite to an antenna at LSU. An important breakthrough will be the architectural design facilitating a fiber optic backbone with spurs linking to each station. In the future, the coastal ocean observing data arriving at LSU from remote sites would be transmitted via local campus network to the LSU Office of Computing Services. All the data would be collected and managed by the LSU Office of Computing Services data center using state-of-the-art RAID storage as an extension of existing facilities and services. These data will be available 24 hour per days 365 days of the year and accessible via Internet and Internet2. Based on standard available archiving service, some of the collected data will be

periodically transferred to offline storage and retrieved with a several second delay to online storage when needed.

There is a vanishing window during which systems can be taken offline for backup purposes without disrupting normal operations. These data can be mirrored and stored redundantly in two or more collections of disks, rather than one. Mirroring is a parallel process and thus there is no performance penalty. The remote copy of these data would be a replicate of the data stored at LSU. Data would be transmitted over a distance to a second storage system for safekeeping. This transfer would be handled by a high-speed network and woven into the ongoing process of mirroring the data. We would seek to utilize SURAnet extensively.

Catalyst for Innovation and "The New Economy"

There are numerous facets of our proposal that are clearly aligned with the south's "New Economy" and research, development and technology. Several examples are presented below to underscore that we are indeed cognizant of the needs and objectives of the IT-initiative.

Human Capital Investment

Significant advances in education can be achieved and will include the development of new expertise in the fields of remote sensing, coastal oceanography, sediment transport, modeling and the training of students in science and engineering. Undergraduate and graduate students will benefit from assisting in designing and maintaining state-of-the-art satellite receiving stations and coastal observation systems, gathering expertise in electrical engineering, computer science, environmental science/engineering, oceanographic data processing and analyses and satellite remote sensing. Distance learning can be easily achieved given the advanced nature of data assimilation and dissemination through the Internet. It is important to note that that our effort has been conceived in close communication with colleagues from other departments and colleges who are developing a curriculum in Disaster Sciences and Sustainable Communities. Several of us are involved in the latter effort and have endeavored to ensure that both are complimentary. Thus, to avoid redundancy, we do not expand on the curriculum component here although we acknowledge its significance to the IT-initiative. The future success of this curriculum is highly dependant on unique, timely and accurate data sets such as we propose here; similarly, a greater understanding of the data sets we provide among students in an academic setting can be achieved through implementation of such a curriculum.

Regional collaboration among academic institutions and local govemments can also be enhanced. Data that are conveniently stored can often lead to a dramatic increase in their use in research. This increased use could be a data-mining application where more data are searched. We perceive a considerable increase in technology transfer with state agencies with respect to the overall goal of enhancing coastal stewardship, emergency management and preparedness as well as providing the constituents of our State current environmental conditions for recreational use.

Research Competitiveness and Industry Investment

We are confident that if supported by the Louisiana IT-initiative, our research competitiveness for federal funding would increase rapidly and considerably and the following is an example of our success to date. Since inception, both offshore observing (WAVCIS) and remote sensing (Earth Scan Laboratory) programs, initially funded by State monies obtained from LEQSF, have resulted in an approximate 25 to 28-fold increase in external funding, a considerable percentage of which is federal. As shown in Figure 1, over an eight-year period, WAVCIS funding increased from an initial seed amount of $125,000 in 1992 to $3.45 million by 2000. Earth Scan since inception in 1987 went from $248,000 to $6.122 million by 2000. Given the longer-term research agendas of major federal funding agencies and using the Office of Naval Research and the National Science Foundation as two examples, our competitiveness would increase dramatically in that we will provide a unique offshore laboratory for numerical modeling validation and skill assessment.

To date we have played a small role in support technology commercialization. With additional technical support, this effort would increase considerably given the utilization of broadband and the consequent need for a new systems' architecture. New generations of wireless communication will improve data transmission and our observing system could provide a test installation for new development. With enhancement we would be better poised to attract industry investment, particularly in the area of rapid real time measurement of hydrodynamic conditions offshore. Coupled to numerical models and satellite

borne data, we would be capable of responding to many pressing needs among the oil and gas industry in the Gulf of Mexico. The vision is that our instrumentation and high-speed data transmission technology become a fundamental part of all future oil and gas infrastructure to be deployed offshore. This would ultimately provide an unparalleled ocean observatory in the Gulf that would add a completely new dimension to fundamental coastal oceanographic research.

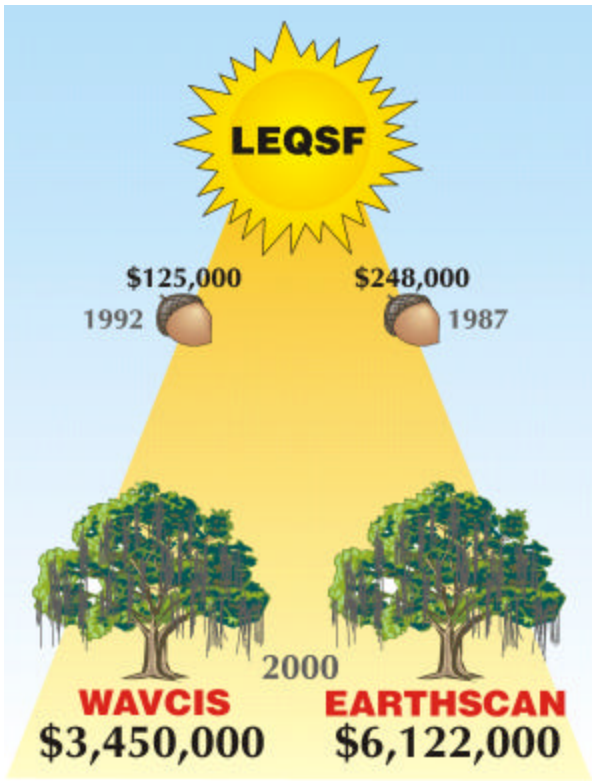

Figure 1. Initial seed investments for observing systems and cumulative research investment return.

Summation

We believe that Governor Foster's IT-initiative is important and timely for our efforts regarding involvement with regional/national ocean observing initiatives including SURA. By obtaining support from the Louisiana IT initiative, we would be perfectly poised to play a leadership role and serve as an incubator and training ground for a new generation of highly sophisticated coastal observing systems. This would afford us the opportunity to reach new frontiers in fundamental and applied research, training of undergraduate and graduate students, technology commercialization and coastal stewardship.