NGI/NE/04

Wireless Environmental Observatory

FY 2003 Proposal to the NOAA HPCC Program

August 19, 2002

Principal Investigator:	**Steven A. Ruberg**
Line Organization:	OAR/GLERL
Address:	NOAA/GLERL 2205 Commonwealth Blvd. Ann Arbor, MI 48105
Phone:	(734) 741-2271
Fax:	(734) 741-2055
E-mail Address:	Steve.Ruberg@noaa.gov

Dr. Harvey Bootsma
hbootsma@uwm.edu

Ronald M. Muzzi
Ron.Muzzi@noaa.gov

Proposal Theme:	**NGI Networking Technologies**
Funding Summary:	FY 2003 $ 80,130.00

Steven A. Ruberg
Technology Development Program Manager
NOAA/OAR/GLERL

Dr. Harvey Bootsma
Assistant Scientist
University of Wisconsin - Milwaukee

Ronald M. Muzzi
Electronics Engineer
NOAA/OAR/GLERL

Wireless Environmental Observatory

Proposal for FY 2002 HPCC Funding

Prepared by: Steven A. Ruberg

Executive Summary:

A prototype wireless environmental observation system will be developed that is capable of providing real-time observations of chemical, biological, and physical parameters. The Ethernet-based system will include an underwater hub and surface buoy providing web-accessible data and instrument control. When fully developed, the system will allow researchers to not only manage and store data but allow modification of sensor sampling rates and initiate discrete events.The system will be installed and tested at GLERL's Lake Michigan Field Station in Muskegon, MI and at the University of Wisconsin's Great Lakes WATER Institute complementing existing web accessible meteorological stations and Waterbase real-time observations. The system is being designed for portability to allow deployment in a variety of coastal areas and the Great Lakes region.

Through the real-time data access program proposed here, we will be integrating the results of two major monitoring programs conducted on Lake Michigan by NOAA GLERL and the UWM Great Lakes WATER Institute. Because these two programs operate on opposite sides of Lake Michigan, this integrated information will greatly improve our understanding of large-scale physical, chemical and biological dynamics in Lake Michigan, and will provide a more solid foundation for responsive management decisions.

Data collected from the system will be integrated with GLERL's Real-Time Meteorological Observations Network (www.glerl.noaa.gov/metdata) and Great Lakes Water Resources Institute Waterbase real-time observations (waterbase.uwm.edu).

Problem Statement:

There is currently a need to provide real-time high-bandwidth data for scientific, educational, and public awareness purposes. Most data collection systems are designed to address a specific question with no capability for system expansion or the addition of sensors from external organizations. An observation methodology that allows quick reaction to changing environmental conditions does not presently exist. Current communication systems do not have adequate bandwidth to support the collection of streaming video for scientific and public outreach purposes.

This project will evaluate the use of IEEE 802.11 based wireless LAN technology and a universal hub configuration to address these deficiencies. The technology will demonstrate real-time access to high bandwidth data and allow environmental sensor reconfiguration via the internet.

This proposal addresses the NOAA HPCC NGI objective of advancing wireless networking technology within NOAA.

Proposed Solution:

A shore station, surface buoy, and underwater hub will be assembled and deployed at Muskegon, MI and Milwaukee, WI to allow real-time high-bandwidth data collection. The shore station and surface buoy will communicate at data rates up to 10 Mb/s using a IEEE 802.11 compatible wireless LAN. High gain directional antennas and pre-amps will be used to extend range up to 10 km and preserve bandwidth. This system will have the capability for point-to-point and point-to-multipoint connections allowing environmental data collection over a greater spatial area in the future. The surface buoy will provide power and Ethernet connections to the underwater hub as well as serve as a platform for meteorological sensors. The underwater hub provides a standard interface to enable the integration of sensors with digital and analog outputs. Analog sensors are converted to a serial RS232 format with all serial I/O then routed through a port server. This interface, along with web access, will allow simplified sensor installation and data access by institutions external to NOAA and UWM creating an environmental data collection infrastructure as opposed to an ad hoc data collection system. Additional underwater nodes can be connected through an Ethernet twisted pair connection. Video data is converted to digital format and sent to the surface buoy over the Ethernet connection. All bus traffic monitoring and buffering is handled through a LINUX based bus monitor.

Assembly and installation of surface buoy and underwater hub components will be done by instrumentation specialists in GLERL's Marine Instrumentation Lab and at UWM. Deployment of underwater moorings and surface buoy communications systems will be done using the University of Wisconsin's R/V Neeskay and GLERL's R/V Laurentian.

Analysis:

Current real time communication strategies have several disadvantages, of which a major one is data transfer capacity. Cell phone and satellite links generally operate at low baud rates, and therefore the transfer of large amounts of data is infeasible. This is not an impediment for simple measurements such as temperature, but other data types such as surface accelerometer measurements (used to determine wave height and direction) and video cannot be effectively transferred with these systems. High band width data transfer would allow for real time access to wave data, which is extremely valuable for boat / ship operators, search / rescue operations, and the validation of wave height now-casts and forecasts made by NOAA. The ability to collect real time video data will open up numerous opportunities in large lakes research. For example, current research being conducted at the UWM Great Lakes WATER Institute is attempting to determine spawning behavior of perch in nearshore waters, and potentially competitive interactions between perch and the exotic goby. Continuous real time underwater observation will allow researchers to monitor spawning behavior and conduct opportunistic sampling. A second focus of research is the ecology of nuisance algae (primarily Cladophora spp.) that grow on the lake bottom. Continuous observation will allow researchers to more accurately monitor Cladophora growth and to determine the causes and timing of Cladophora sloughing that leads to water quality deterioration and beach closings.

Performance Measures:

Milestones

Month 1 - Procure system components
Month 4 - Complete assembly and initial testing
Month 5 - Deploy systems offshore Muskegon, MI and Milwaukee, WI
Month 7 - Complete field tests including range tests, data throughput, data integration
Month 10 - Finalize web accessible data and information interface

Month 12 – Complete project test report

Deliverables

- Shore station, underwater hub and surface buoy – 2 stations
- Real-time and historical web-accessible environmental database
- Test report with recommendations for use of wireless technology in environmental data collection