Wireless Network Allows Monitoring of a Dynamic Coastal Resource.

Luke J. Coletti, Steve E. Fitzwater, Ken S. Johnson

Monterey Bay Aquarium Research Institute, 7700 Sandholdt Road Moss Landing, CA 95039; e-mail: coletti@mbari.org

OS45D-25

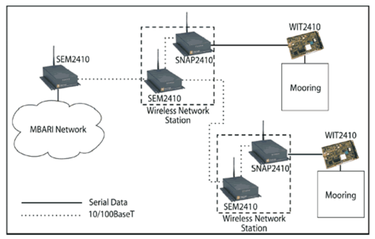
OS45D-25

Abstract

Encompassing nearly 1180 ha (11,798,000 square meters) on the Central California coast the wetlands of Elkhorn Slough are governed by a complex interaction of natural inputs and human activities. Monitoring the response to these inputs requires a diverse suite of in-situ sensors operating at rates that can accurately capture the processes involved. Near realtime telemetry of the sensor data offers a unique opportunity to gain insight into these processes as well as monitoring the health of the instrumentation. The Land/Ocean Biogeochemical Observatory (LOBO), jointly funded by NSF and MBARI, is a five year project to construct and operate an array of moored instrument platforms for this purpose. Performance of the mooring's telemetry system is shown to include a six month service free deployment period (from a single 30 Ah battery pack) with hourly transmissions of the logged sensor data, which currently includes ISUS nitrate, CTD, fluorometer, Oxygen Optode and an ADCP. The development of the LOBO Acquisition and Telemetry Engine (LATE) and the implementation of a 2.4GHz FHSS (frequency hopping spread spectrum) wireless network, to distribute connectivity throughout the estuary, are presented.

LOBO Mooring in Elkhorn Slough

Wireless Network

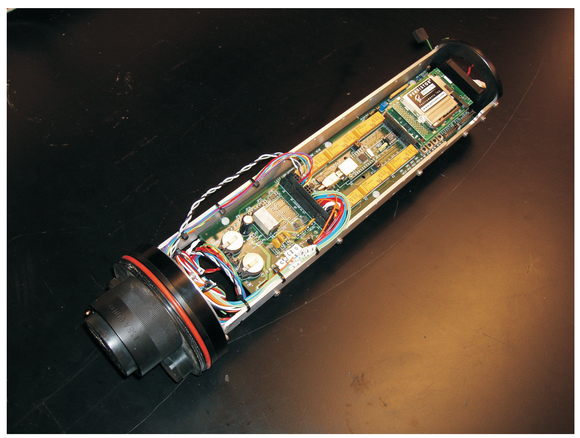


In order to reliably telemeter data from multiple sensor clusters (moorings) a Wireless LAN topology employing Frequency Hopping Spread Spectrum (FHSS) radios within the 2.4GHz ISM band was chosen. Wireless LAN employing Direct Sequence Spread Spectrum (DSSS), such as the ubiquitous 802.11b, was avoided since high bandwidth data is unnecessary for this application and the inherent bandwidth loading of this topology would limit network capacity and reliability. For example, a single DSSS transceiver utilizes nearly 35% within the ISM band as opposed to only 1% for the FHSS system chosen. Other key considerations were ultra low power operation, seamless network socket connection of remote radios to shore side computers and size.

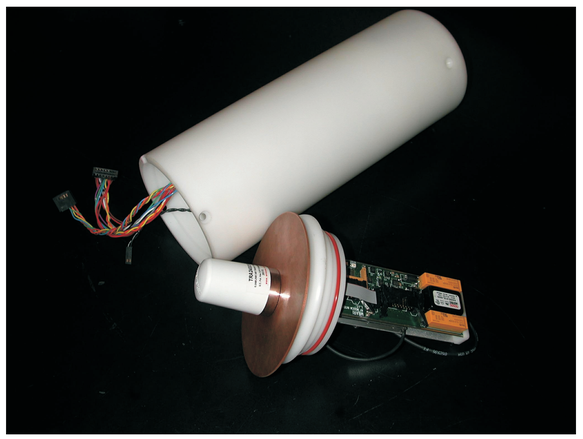
Each instrument cluster (mooring) is managed by a custom controller/datalogger that was designed for this project. The controller is responsible for acquiring and telemetering instrument data back to a shore side UNIX server using a Wireless LAN radio MODEM. The controller can log and telemeter the data from up to 8 serial (RS232 or RS485) instruments for up to 6 months on a single battery pack. A low-power OEM Wireless LAN radio module (Cirronet WIT2410) is used to telemeter the data at regular intervals. When powered, the WIT2410 establishes connection with the Access Point transceiver (Cirronet SNAP 2410) managing its coverage zone, each coverage zone has a unique frequency hopping pattern and band to minimize interference. Upon receiving an incoming radio connection the Access Point seamlessly establishes a network socket connection to a shore side UNIX server using a paired Wireless Ehternet Bridge (Cirronet SEM 2410) that it's connected to. The Access Point socket connection to the remote server is managed by a custom server application running out of INETD that was designed as part of the project. The INETD server application decodes the incoming connection to identify its source, it then performs a series of handshake services that include updating the controller's realtime clock, determining over-the-air transmission rate and other house keeping functions. Finally, the controller performs its data transfer using ZMODEM, a 32 bit CRC binary file transfer protocol. Porting of both the embedded ZMODEM client and UNIX ZMODEM server were done as part of this project.

The Elkhorn Slough watershed is vast and coverage requires the bridging of multiple Access Point transceivers to form a seamless extension to the MBARI shore side network. Wireless Ethernet Bridges (Cirronet SEM 2410) allow for remote Ethernet access to the field deployed Access Points, which in turn manage the instrument cluster radios. Extending the network with Wireless Ethernet Bridges allows other Ethernet based equipment, e.g., remote weather stations, webcams, to be connected as well.

Wireless Network Station services upper Elkhorn Slough

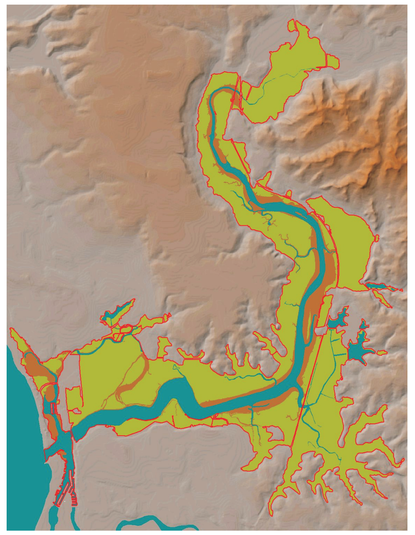


Instrument data is logged and telemetered by a MBARI designed datalogger, shown above. The datalogger can communicate with up to eight serial devices and transmit hourly for up to six months from a single battery pack.



The LOBO radio assembly, shown above, incorporates a MBARI designed interface that provides electrical isolation between the LOBO datalogger and the Cirronet WIT2410 Wireless LAN module. Electrical isolation of the data and control lines minimizes sensitivity loss in the radio due to conducted emissions.

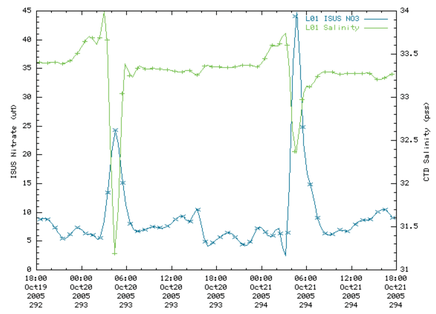
Elkhorn Slough, California



The tidal wetlands of Elkhorn Slough, outlined above in red, encompass some 1180 ha (11,798,000 square meters).

An AVIRIS image reveals the various activities surrounding Elkhorn Slough. Inputs from various sources which can include nearby farm and ranch land as well as industrial sites can be monitored in near real-time using LOBO.

An ariel "KiteCam" photo shows the migration of a high nitrate low salinity "plume" which passes through the Moss Landing harbor and approaches the inlet of Elkhorn Slough. This water mass enters the slough on the next incoming tide and is a significant source of nitrate.



High nitrate low salinity events are measured at the LOBO L01 mooring which is located near the inlet to Elkhorn Slough (see also image and description to left).

Acknowledgments

Funding is provided by a National Science Foundation BioComplexity Grant (ECS-0308070) and by MBARI by a grant from the David and Lucile Packard Foundation.

Thanks to both Don Neas and Ryan Anderson at Cirronet for their technical support..

Thanks to Gary. Thurmond (MBARI) for the aerial "KiteCam" image..

Thanks to Andy Fischer (MBARI) for the true-color AVIRIS image.

Thanks to Eric Van Dyke (ESNERR) for the Elkhorn Slough tidal wetlands image.