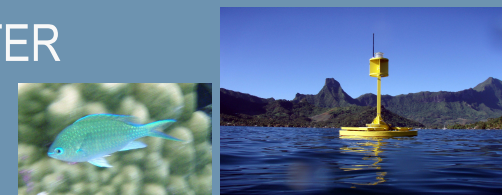


Streaming Data Cyberinfrastructure at Moorea LTER

T. Fountain¹, P. Shin¹, S. Tilak¹, P. Arzberger¹, M. Gastil-Buhl², S. Holbrook², R. Schmitt², A. Brooks², K. Seydel²
 1. University of California San Diego {tfountain, pshinn, stlak, parzberg}@ucsd.edu;
 2. University of California Santa Barbara {holbrook, schmitt}@lifesci.ucsb.edu, {brooks, gastil, seydel}@msi.ucsb.edu



Overview

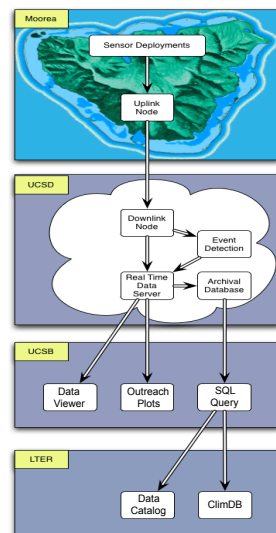
Digital Moorea is a collaborative vision of a coral reef ecosystem instrumented with real-time sensors connected to high-performance backend resources and sophisticated client applications. It will be a living laboratory for long-term studies of marine ecology and a test bed for evolving technologies for environmental and biological sensing, communications, and analysis. A diverse team of ecologists, computer scientists, and engineers from the Marine Science Institute at the University of California Santa Barbara (MSI, msi.ucsb.edu) and the California Institute of Telecommunications and Information Technology (CalIT2, www.calit2.net) are collaborating to bring this vision to reality at the Moorea Coral Reef site (MCR LTER, mcr.lternet.edu) of the U.S. National Science Foundation's Long Term Ecological Research (LTER) program.



The Moorea Coral Reef Long-Term Ecological Research site (MCR LTER)

The Moorea Coral Reef Long-Term Ecological Research site (MCR LTER) is the complex of coral reefs and lagoons that surround the island of Moorea, French Polynesia. Coral reefs represent one of the most diverse ecosystems on earth. Unfortunately, the world's coral reefs are disappearing at an alarming rate. Current estimates indicate that almost 20% of the world's coral reefs have been lost and another 35% are in serious danger of being lost by 2050 due to the effects of coastal development, over-fishing and multiple factors associated with global climate change. The primary goal of the Moorea Coral Reef Long-term Ecological Research site is to explore the effects of these external drivers on the fate of the coral reefs.

System Architecture



Island infrastructure

Sensors, data acquisition devices, routers, DSL modem, serial to Ethernet converter, UPS.

UCSD Data Center

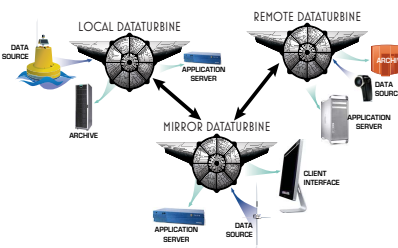
Downlink Node for receiving data, Servers for data management, DataTurbine server, event processing engine, databases.

Client applications

Data viewers, analysis packages, database query

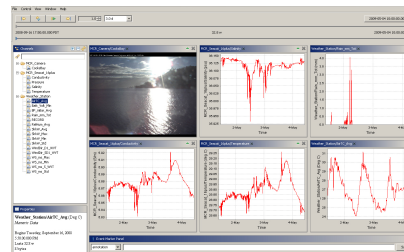
Sensor	Type of Measurement	Sampling Interval
Seacat CTD 16 plus	temperature, conductivity, salinity, pressure	2 minutes
HMP 45C temperature and relative humidity	temperature, relative humidity	5 minutes
LI200X Pyranometer	solar radiation	5 minutes
TB4-1 Rain Gauge	rain	5 minutes
CS100 Barometer	pressure	5 minutes
Wind Monitor	wind direction and speed	5 minutes
Axis 223M Camera	mjpeg video	5 minutes

Open Source DataTurbine



DataTurbine is a streaming data engine. It supports the development and operations of sensor-based systems by consolidating complex data stream management tasks into a uniform framework that is modular, scalable, and robust. DataTurbine provides (1) a programming abstraction over heterogeneous devices and (2) a suite of integrated network services for managing streaming data. DataTurbine makes disparate devices look similar. Data streams from diverse instruments are integrated and managed by a common Application Programming Interface (API). From the perspective of distributed systems, the DataTurbine middleware is a "black box" to which applications and devices send and receive data. DataTurbine handles important data management operations between data sources and sinks, including reliable transport, routing, and scheduling.

MCR Sensor Streams in RDV

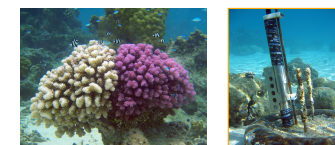


Future:

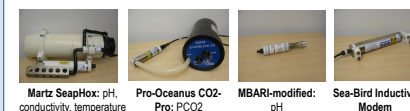
Ocean Acidification Research



While coral reefs have undergone unprecedented changes in community structure in the past 50 years, they now may be exposed to their gravest threat since the Triassic. This threat is increasing atmospheric CO₂, which equilibrates with seawater and causes ocean acidification (OA). Key to understanding this process is measurements by OA-related sensors including pH, PCO₂, temperature, and pressure.



The deployment of OA-related sensors at MCR and the collection of measurements from these sensors will provide valuable insights into OA and lay the foundation for larger more rigorous OA studies in the future. The ability to measure these phenomena in-situ and in real-time represents a significant advance in our ability to monitor key environmental processes. The OSDT Android Sensor Pod will provide a critical building block for enabling new science experiments on OA and the results will be applicable to other coral reef researchers and members of the Coral Reef Environmental Observatory Network (CREON, www.coralreefeon.org).



OPEN SOURCE DATA TURBINE INITIATIVE
 Empowering the Scientific Community with Streaming Data Middleware