Managing Sensor Network Configuration and Metadata in Ocean Observatories Using Instrument Pucks

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Large Scale Ocean Observatories Present Challenges of Configuration, Metadata Management

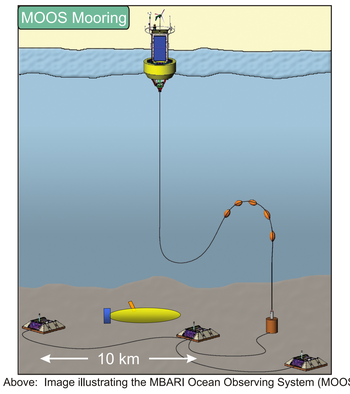
Introduction

Cabled observatories, such as the Monterey Accelerated Research System (MARS) or the regional scale cabled observatory system planned for in the NSF Ocean Observatories Initiative (OOI), consist of many deployed instruments that communicate with human operators and shore-side data repositories. In addition, these deployed devices may actually communicate with one another, facilitating capabilities such as autonomous event response. These potentially complex interactions between multiple entities - human and machine - require that knowledge of the system configuration be available to participants. Users of instrument data require information - metadata - about the sensor that generated the data. Software that coordinates and controls instruments requires access to the software interfaces of those devices. "Manual configuration" has been used on small-scale systems, but in a network consisting of hundreds or thousands of instruments, the configuration challenge becomes critical. We propose to address the problem through automation of the configuration process, which will be achieved at several levels.

Automated configuration will simplify the system operator's task of building and maintaining the observatory network. We describe a small, low-powered information storage device that we call a "instrument puck". When plugged into a suitable computer (lab workstation, deployed observing node), information can be written to or read from the puck. While an instrument is being prepared for initial integration into the observatory, a technician "loads" a puck with information necessary to configure the instrument within the observatory, and then physically attaches the puck to its instrument. Thereafter the attached puck always travels with its instrument, no matter where it is being installed in the observing network.

The information loaded into the puck encompasses whatever is necessary to enable automatic configuration and system integration of the instrument when it is plugged into the observatory network, and any other information required by observatory policies. This information may include structured descriptions of the instrument's sensor and data characteristics (metadata). The information can also include actual software code that is retrieved from the puck and executed by an observatory node when the device is plugged in; this code could implement distributed instrument control and data retrieval interfaces, allowing network-wide access to the instrument functionality. We believe the puck concept to be a powerful one; a given instrument puck is configured just once, enabling automatic configuration of its instrument no matter where it is installed on the network thereafter.

We also describe mechanisms by which an instrument and its puck can be "discovered" by the observatory network when the devices are plugged in. Several approaches are explored, with varying degrees of automation. We evaluate these approaches with special consideration to electrical and safety aspects of the undersea environment. Information and results from our prototyping efforts will also be presented.



Above: Image illustrating the MBARI Ocean Observing System (MOOS).

- Wireless communications to shore
- Power (20-100 W) and data (10 Mbit/sec) to the seafloor
- 4000 meter depth
- 10 km Benthic runs
- Support for AUV docking
- Moored network of benthic, midwater, and surface nodes
- Instruments can be accessed in near-realtime over satellite or RF link

Ocean Observatory Challenges

With Greater Capabilities.....

- Greater variety of Instrumentation
- Highly Integrated data collection
- Cooperation between a variety of platforms (AUV, ROV, Moorings)
- Adaptive sampling
- Event detection
- Wider Coverage (Surface to Seafloor)

Come New Challenges.....

- Platform Configuration Management
- Metadata Management
- Diverse Software Protocols
- Operational Scalability
- Power Management
- Intermittent, Low-Bandwidth Telemetry Links

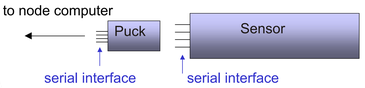
Instrument Pucks Improve Observatory Scalability by Binding Metadata to Their Sources

The *Plug-and-Work* Solution...

- Physically plug device into host serial port
- Instrument service is (almost) *automatically* retrieved from the puck
- Metadata are *automatically* inserted into the archiving data stream whenever relevant changes occur
- Distributed software makes device services and metadata accessible to all users and network nodes

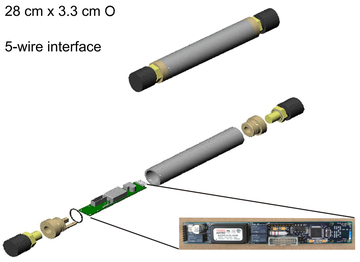
What Information is Stored in the Puck?

- **Sensor ID and Metadata**
  Instrument type, default settings, owner, etc…
- **Instrument Service Code**
  Downloaded and executed on node when instrument is plugged in

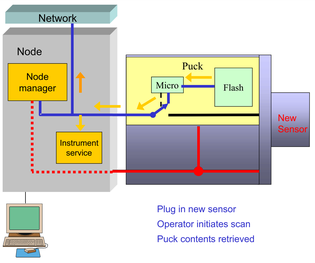


Puck Specifications

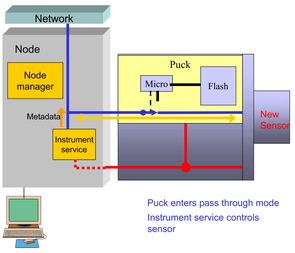
- Supports RS-232 or RS-485 up to 115 Kbps
- 1 MB flash (configurable) for instrument service code and metadata
- Typical Instrument Service code is 10-15 Kbytes
- Typical metadata size TBD
- Power consumption (0.40 W quiescent /1.06 W during I/O) currently driven by COTS isolated power supply; target is 0.030/1.00 W)
- 4000 m housing
- 28 cm x 3.3 cm O
- 5-wire interface



Puck Operation During Platform Configuration



Plug in new sensor
Operator initiates scan
Puck contents retrieved



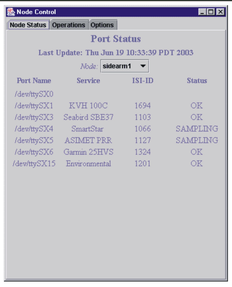
Puck enters pass through mode
Instrument service controls sensor

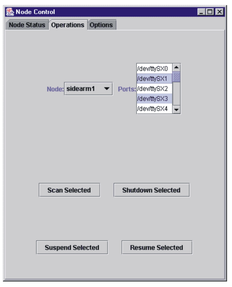
Instrument Pucks Applied to Ocean Observatories: Results and Current Status

Activities to Date

- **MTM-1 Deployment:** *Winter 2002 (completed)*
- **Puck Prototype Hardware:** *Spring-Summer 2003 (completed)*
- **AOSN Deployment:** *Summer 2003*
- **CIMT Demo:** *Autumn 2003*
- **MTM-2 Deployment:** *Autumn 2003*
- **MTM-2 Deployment II:** *Spring 2004*
- **MOOS Science Experiment:** *Spring 2004*

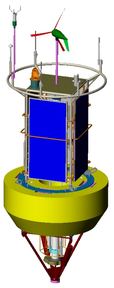
Node Browser Prototype



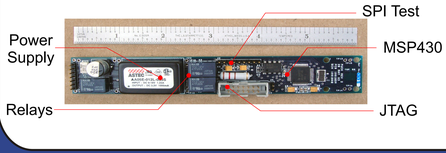


SIAM Deliverables

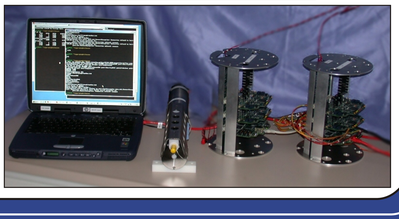
- Node networking
- Instrument control
- Data acquisition
- Metadata management
- Plug-and-Work: Instrument Pucks
- Autonomous event response
- Utilities for
  - System integration
  - Deployment
  - Maintenance
- Shoreside portal gateway
- Instrument user interfaces



Puck Hardware



MMC Nodes



Compiled by Karen A. Salamy for MBARI, June 2003