EVALUATION OF MBARI PUCK PROTOCOL FOR INTEROPERABLE OCEAN OBSERVATORIES

Joaquin del Rio[1], Tom O'Reilly[2], Kent Headley[2], Duane Edgington[2], Dan Toma[1], Jesper Zedlitz[7], Frank Johnson[3], Greg Johnson[3], Eric Davis[4], Klaus Schleisiek[5], Neil Cater[4], Reo Phillips[6], Eric Delory[8], Christoph Waldman[9]

(1) SARTI, Technical University of Catalonia, Joaquin.del.rio@upc.edu, (2) MBARI, oreilly@mbari.org, 3RBR, (4) Fisheries and Marine Institute of Memorial University of Newfoundland, (5) SEND, (6) AXYS, (7) Kiel University, (8) dBScale, (9) MARUM University(3) Dept. Of Signal Theory and Communications. Technical School of Castelldefels (UPC).

Abstract - IEEE-1451[1] and OGC Sensor Web Enablement (OGC SWE)[2] define standard protocols to operate instruments, including methods to calibrate, configure, trigger data acquisition, and retrieve instrument data based on specified temporal and geospatial criteria. These standards also provide standard ways to describe instrument capabilities, properties, and data structures produced by the instrument. These standard operational protocols and descriptions enable observing systems to manage very diverse instruments as well as to acquire, process, and interpret their data in a uniform and automated manner. We refer to this property as "instrument interoperability". This paper describes integration and evaluation of MBARI PUCK protocol [3] within different observatories including OBSEA [4,5] in Spain, the ESONET test-bed in Germany, and the SmartBay observatory in Canada.

Keywords - MBARI PUCK Protocol, Instrument Interoperability, IEEE1451, OGC SWE

INTRODUCTION

To achieve instrument interoperability, the physical instrument must be reliably associated with software and information that conform to standard protocols and descriptions. In most cases today, the "firmware" that is physically embedded within the instrument does not conform to standards; instead standards-compliant external instrument "driver" software and metadata files residing on observatory host computers are logically associated with the physical instruments. Setting up the logical association is typically a manual process; technicians must install instrument driver software on the host, specify a host data port where the instrument is installed, and specify baud rates, configuration files, and so on. This manual configuration process can be tedious, time-consuming, and hence prone to human error. Moreover the configuration process must sometimes be performed aboard ships and buoys under severe environmental conditions that challenge human physiology and psychology, thus increasing the chances for error.

An alternative approach is to embed the standards physically within the instrument; in this case the instrument will respond appropriately to standard operational protocols, and will supply descriptive information in standard format. Thus the observing system can automatically identify the instrument and utilize the instrument and its data when it is physically installed, and there is no need for technicians to manually set up a logical association between physical instrument and host drivers and configuration files. There are several challenges to this approach that can be solved by using standards such as IEEE1451, OGC SWEand MBARI PUCK protocol described below.

IEEE-1451 and OGC SWE

IEEE-1451 and OGC SWE are rather complex, which is to be expected as these standards are also quite comprehensive. This complexity presents challenges for instrument manufacturers who must thoroughly understand the standard and who must correctly implement it in firmware. Moreover embedded instrument processors are often designed for low cost and low-power environments, and hence may not be capable of fully implementing the standards. Another drawback is that manufacturers would likely have to abandon existing instrument firmware that does not implement the standard; this existing firmware often represents a very considerable investment by the manufacturer. A third drawback is that IEEE-1451 and OGC SWE are still evolving, again due to the comprehensive nature of these standards. Thus either the standard revision process must be very carefully managed to ensure "backwards compatibility", or instrument firmware must be occasionally upgraded to remain compliant with the latest standard. Both of these alternatives present non-trivial challenges to instrument manufacturers and standards bodies.

MBARI PUCK Protocol

A third approach is implemented by MBARI PUCK protocol, which does not itself implement interoperability, but rather provides the lower tier in a hierarchy of standards that achieve this goal. PUCK defines a simple standard embedded instrument protocol to store and retrieve information from the instrument. The information consists of a minimal instrument datasheet that includes a universally unique instrument serial number, a manufacturer ID, and a small amount of other metadata PUCK protocol also allows an optional "payload" consisting of any information needed by a particular observing system. The payload format and content are not constrained by PUCK protocol, and can include executable driver code that implements a standard operating protocol as well as metadata that describe the instrument in a standard way. Using PUCK protocol, technicians can store payload contents with the instrument before deployment. When the instrument is deployed, payload is retrieved by the host and utilized appropriately; e.g. the host can execute the driver code, and can use or distribute the standard metadata to other locations on the network. Thus standard IEEE-1451 and OGC SWE components can be automatically retrieved and installed by the host when a PUCK-enabled instrument is plugged in, overcoming the difficulties of manual installation. PUCK protocol is simple, and readily implemented in even simple instrument processors; several manufacturers now implement MBARI PUCK protocol in their instruments, and report just a few weeks of engineering effort to do so. PUCK protocol augments rather than replaces existing instrument protocols, and manufactures can usually implement PUCK by extending their existing protocol rather than starting from scratch. Since the protocol is simple, it is likely to be stable, so manufacturers to do not have to modify firmware to keep up with an evolving standard. As higher-level IEEE-1451 and OGC SWE standards evolve, the instrument PUCK payloads can simply be updated through PUCK protocol.

PUCK INTEGRATION

Until recently, PUCK protocol was used exclusively on MBARI moored and cable-to-shore observatories [6]. We describe tests to integrate and evaluate the protocol on several non-MBARI systems, including ESONET test-bed observatories such as OBSEA [3,4] and the SmartBay observatory in Canada. We estimate the engineering effort required to integrate PUCK into these systems, and summarize the benefits gained for that effort. We discuss possible refinements to the protocol and describe plans to submit MBARI PUCK as a formal standard.

REFERENCES

[1] Lee, K., "IEEE 1451: A Standard in Support of Smart Transducer Networking", Proceedings of the 17th IEEE Instrumentation and Measurement Technology Conference, Baltimore, MD, May 1-4, 2000, Vol. 2, p.525-528

[2]George Percivall, Carl Reed "OGC® Sensor Web Enablement Standards", Sensors & Transducers Journal, Vol.71, Issue 9, September 2006, pp.698-706, ISSN 1726-5479

[3] Kent L. HEADLEY, Dan DAVIS, Duane EDGINGTON, Lance McBRIDE , Thomas C. O'REILLY, Michael RISI "Managing Sensor Network Configuration and Metadata in Ocean Observatories Using Instrument Pucks" Third International Workshop on Scientific Use of Submarine Cables and Related Technologies, 25-27 June 2003

[4] Marc Nogueras, Carola Artero, Joquín del Rio, Antoni Mànuel, David Sarrià, "Control and acquisition system design for an Expandable Seafloor Observatory", IEEE OCEANS09, 11-14 May, Bremen, Germany

[5]M. Nogueras, J. Santamaria, A. Mànuel, "Construction of the OBSEA cabled Submarine Observatory" Instrumentation Viewpoint, Num.6, pp33-34, autumn 2007.

[6] T.O'Reilly, K.Headley et al, "MBARI technology for self-configuring interoperable ocean observatories", Proceedings of the Marine Technology Society / Institute of Electrical and Electronics Engineers Oceans Conference, Boston, Massachusetts