ADVANCING THE INTEROPERABILITY OF OCEAN SENSORS. WORKSHOP DEMONSTRATION AT OCEAN INNOVATION 2008 CONGRESS.

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Abstract - The aim of this project is to implement a smart sensor worldwide network based on IEEE 1451 family of standards which can provide multiple interoperable clients to access geospatial and sensor data for national local monitoring. This paper presents part of an integrated ocean observing system (IOOS)developed by SARTI research group which offers remotely access via the Web to sensors and sensor networks in Canada, USA and Europe. It also describes the capabilities and functions of such a network and possibilities to access multiple sensor observation and sensors via OGC SWE and IEEE 1451. The architecture of sensor network is based on the IEEE 1451.0.

I. INTRODUCTION

Nowadays, sensors are everywhere measuring many different parameters in marine, hearth or spatial environments. Access to this information in a simple way is not a simple problem. From sensor device to useful data, a series of mechanism and technologies exist such as sensor conditioning, analogue to digital conversion, data processing software and communication protocols. Many different protocols can be used to get data from an instrument or share information over the network. This variety of protocols make the interconnection of different instruments or systems difficult for final users that are only interested in the real information acquired by the sensors. At this point, interoperability concept takes an important role in data acquisition systems.
Interoperability [1] is the ability of two or more systems or components to exchange information and to use the information that has been exchanged in an organized way.

From the oceanographic instrumentation point of view, many institutions are working on interoperability of different sensor systems in order to exchange information from many different observation platforms. During the Ocean Innovation 2008 Conference at St. John's, Canada, a Workshop Demonstration titled "From Sensors to Applications: Advancing the Interoperability of Ocean Sensors" was presented, where SARTI engineers collaborated with other institutions with the purpose of demonstrating the implementation of IEEE and OGC standards to rapidly access, fuse and apply sensor information from a range of in-situ to worldwide earth observation platforms for early indication and monitoring. Table 1 shows a list of participants and institutions and Figure 1, places where the sensors are installed around the world (USA, Canada and Europe).

This was a live event where participants accessed sensors and sensor networks remotely via the Web and Web services in Canada, USA, Europe. Multiple client applications were accessing sensor systems and data. Figure 3, shows the full schema of the workshop demo.

II. RELATED WORK

SARTI's research group has been working on the IEEE1451.0 [2] standard. IEEE 1451 family of standards defines a set of common communication interfaces for connecting smart transducers (sensors or actuators) to microprocessor-based systems, instruments, and networks in a network-independent environment. The main objective of the work presented by SARTI in the Ocean Innovation Demo was the distribution of information acquired from a CTD instrument under IEEE1451.0 standard, commonly used in underwater observation systems to monitor mainly pressure, temperature, salinity and conductivity. Our CTD was placed inside a hyperbaric chamber where pressure was changed periodically. A computer running on a client software in Canada, had to be able to discover what parameters were measured by our system in Barcelona and read data from it. This communication between both systems (server and client) was established under IEEE1451.0 standard.

Our system diagram is represented in figure 2. A laptop computer as a Network Capable Application Processor (NCAP) executes a HTTP server* developed in JAVA that receives the HTTP commands from a client software. NCAP processes the command and returns the information required. Figure 3 represents a simplified flowchart diagram of the software application for IEEE1451.0 HTTP Server.

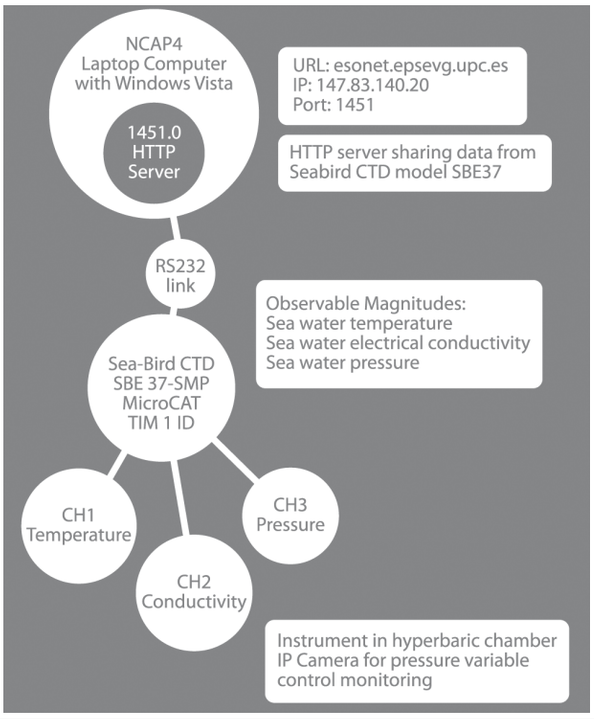
Name	Assoctiation
Jeff de La Beaujardiere	NOAA
Philip Bogden	GOMOOS
Luis Bermudez	SURA
Pat Cappelaere	Vightel (for NASA)
Joaquín del Río	SARTI/UPC (for ESONET)
Daniel Thoma	SARTI/UPC (for ESONET)
Scott Fairgrieve	Northrop Grumman
Eric Delory	dbScale (for ESONET)
Kang Lee	IEEE 1451, US NIST
Eugene Song	IEEE 1451, US NIST
Mark Reichardt	OGC
Tom O'Reilly	MBARI
Kent Headley	MBARI
Rob Thomas	Compusult/SensorBay
Christoph Waldmann	MARUM (for ESONET)

Table 1. Participants of Workshop Demonstration

Figure1: Sensor Location around the world

III. 1451.0 IMPLEMENTATION

Figure 4 shows the diagram of the Java server application for an NCAP connected to a CTD through RS232 interface. The program consists of two processes, one for retrieving data from CTD and the other to establish a HTTP 1451 server which responds to the client command. The HTTP 1451 server is updated every time a new TIM is connected to the NCAP or a new channel is created for a TIM. Using this concept, the effort for integration is reduced to minimum and gives good flexibility to add new sensors and a rapid mobilization of new sensors. Being connected to Ethernet and providing an easy way for client to interrogate a sensor, this network of "plug and play" sensors offers a greater collaboration and sharing.



Commands	Response
TIMDescovery	NCAP Id TIM Id
TransducerDiscovery	NCAP Id TIM Id Number Of Channels Channel Id Channel Name
ReadTeds	NCAP Id TIM Id Channel Id Teds Type Teds Data
ReadData	NCAP Id TIM Id Channel Id Transducer Data

Table 2.HTTP 1451 Command-Response

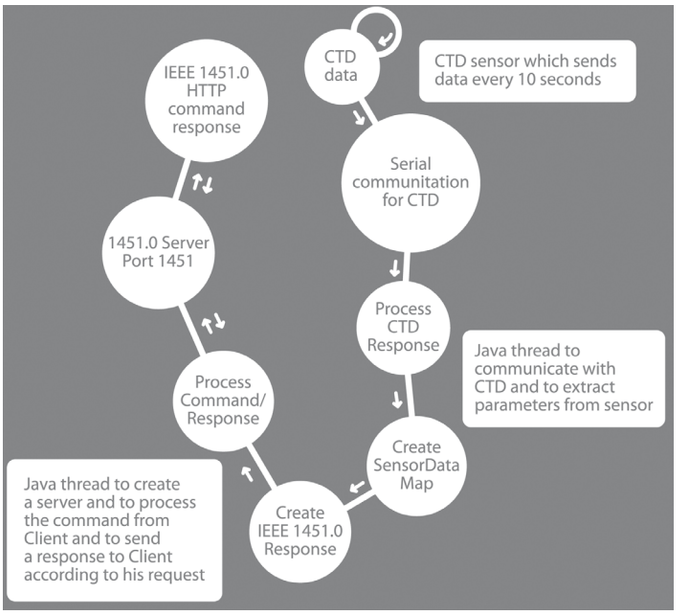


Figure 4: Simplified flowchart of 1451.0 http server

Figure 2: Syste diagram and technical information

SUMMARY

In Sensor Interoperability in Ocean Innovation project, open standards to enable plug and play interoperability across a range of sensors and data feeds, have been applied. Implementations are occurring in ocean observation, defense and other communities of interest. Use of these open sensor standards as a "best practice" benefits developers, integrators and users.

ACKNOWLEDGEMENT

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REFERENCES

[1] Institute of Electrical and Electronics Engineers. IEEE Standard Computer Dictionary: A Compilation of IEEE Standard Computer Glossaries. New York, NY: 1990.

[2] IEEE 1451.0-2007, Standard for a Smart Transducer Interface for Sensors and Actuators-Common Functions, Communication Protocols, and Transducer Electronic Data Sheet (TEDS) Formats, IEEE Instrumentation and Measurement Society, TC-9, The Institute of Electrical and Electronics Engineers, Inc., New York, N.Y. 10016

Figure3: Full schema of the Workshop demo