RANDY GILLESPIE

SmartBay

Applied ocean technology for ocean monitoring

by Bill Carter and Randy Gillespie
Centre for Applied Ocean Technology

At the Centre for Applied Ocean Technology (CTec) we focus on the technological approach to understanding our oceans. This is particularly true for our approach to ocean observation. We subscribe to the notion that technology combines knowing and doing through systematic design to achieve a practical result. Developments in technology are always motivated by human need and rely on careful design and skillful synthesis of inputs from many disciplines which, in our case, include computer science, physics, chemistry, wireless communications, nautical science, engineering, and even logistics to tackle the problem at hand. In this essay we outline our approach to ocean monitoring, which we believe has broad applicability to ocean enterprise, ocean science, engineering and good ocean governance.

The CTec approach involves, first and foremost, listening to the end user(s), clearly understanding their data/information requirements and ultimately identifying and assembling appropriate sensors and services into an ocean observation 'infrastructure' customized to meet specific end-user needs, yet open and extensible in anticipation of future needs. The infrastructure is built around well known international standards and the design recognizes that properly collected, processed and managed data can have a multitude of applications beyond the primary acquisition purpose.

Experience has shown that effective presentation of user-defined information can be the tipping point between success and failure of an applied ocean observation effort. The acquisition of ocean data represents a significant investment. However, in and of itself data represents little value to the end user. It only has real value when it tangibly benefits the end user - whether that be mariner, regulator or researcher. In the vast majority of instances data must be refined into information and applied as knowledge before it can have a practical application. The requirement to turn data into application-specific information products, deliver and present these products to the end user in an efficient and effective manner is and will continue to be a primary thrust of CTec ocean observation efforts.

SmartBay

Placentia Bay is Newfoundland's industrial heartland, and second largest port in Canada in terms of value of goods shipped (mostly because of the 320+ million barrels of crude and refined oil and gas products that are shipped into and out of the bay annually). It is a busy place what with some 400 fishing enterprises and seasonal ferry service to and from Nova Scotia. And it is home to abundant seabird, shorebird, and water fowl populations, along with some 14 species of ground fish, 9 species of pelagic fish and whales, seals and sea turtles. The 1989 Brander – Smith report cited Placentia Bay as the most likely place in Canada for a major oil spill. All stakeholders clearly understand that the impacts of a major incident in the bay would be catastrophic both economically and environmentally.

The Placentia Bay SmartBay project was funded in 2006 under Canada's Ocean Action Plan as a two year demonstration of how ocean technology could be used to support integrated ocean management. The SmartBay system has been in continuous operation ever since. SmartBay physical assets include three met/ocean buoys strategically situated in the bay to support improved forecasting of weather and sea state conditions (Figure 1).

Figure 1: SmartBay realtime data display showing current buoy locations in Placentia Bay. www.SmartBay.ca

Figure 2: CTec technologist installing an automatic information system (AIS) antenna on a Placentia Bay fishing vessel as part of the SmartBay vessels of opportunity program.

SmartBay has proven to be a valuable information resource in support of safe and efficient oil tanker transits into and out of the bay. Other users of SmartBay range from local fishers to foreign-based shipping firms to the research and development community. The buoy data are also used to enhance the four-times-daily custom regional forecasts specific to Placentia Bay and accompanying hour by hour site-specific forecasts generated for the mouth of the bay as well as for the Pilot Boarding Station at Red Island on the east side of the bay. Project partner AMEC Environment and Infrastructure is currently developing coupled met/ocean models that will provide a greater level of accuracy in forecasting the landfall and timing of extreme events such as tropical storms, which with changing weather patterns are becoming more commonplace. Detailed current and oil spill trajectory models for the bay are also under development.

Focus on safety

A number of years back a 45 foot fishing vessel 'disappeared' off the coast of Maine, and a scuff of paint of the same colour was found on an oil tanker tied up in Placentia Bay a few days later. The captain and crew of the tanker claimed to have no knowledge of striking anything en route. The theory is that the tanker was in transit to Placentia Bay in heavy weather and did not detect the small fishing vessel in heavy seas on its radar, or feel the bump in the night. A sad tale, and completely unnecessary with the advent of automatic identification systems (AIS).

AIS is the marine equivalent of the radio transponder that is widely used onboard aircraft. It enables realtime access to a full suite of data about each vessel by the port authority and by every other vessel that is carrying an AIS. In effect, this technology replaces marine radar with something much better in terms of the level of information that is readily and reliably available. While the number of vessel movements in and out of Placentia Bay is not in the same league as, say, the port of Hong Kong (approximately 1200/year for Placentia Bay versus 30,000+ for the port of Hong Kong) the risks are just as great. To date, CTec has outfitted over 70 vessels, most of them small fishing vessels, in Placentia Bay with AIS as part of the SmartBay initiative. Some of this was done with financial support provided by Vale.

The SmartBay met/ocean buoys are also equipped with ATONIS (Aids to Navigation Information System) providing AIS equipped vessels in the area with direct access to buoy data outputs. This information is also accessible via the web in near realtime and is used routinely in support of marine operations in the bay. Worthy of note, the SmartBay buoys were the first in Canada to be equipped with ATONIS.

Better information… better decisions

The overriding goal of SmartBay is better information for mariners. The result is better decisions by mariners in terms of safety and efficiency of maritime operations and sustainability of the ocean environment. As mentioned above, SmartBay began in 2006 as a two year technology demonstration project, and has been going strong ever since. In April 2012 the industrial users in Placentia Bay agreed to pay the annual operating costs of SmartBay, so we believe we must be on the right track. We are also quite proud to say that our industry partners – AMEC and Earth Information Technologies (NL) Limited have been with us since day one.

The technology behind SmartBay is the most complex of any we currently deal with. We take pride in the fact that the CTec team built the SmartBay system from the seabed up. The heart of the system are the sensors that measure things like air and sea surface temperature and current, wind speed and direction, wave height, period and direction, barometric pressure, etc. These sensors ride on a variety of purpose built buoys manufactured by AXYS Technologies in Sidney, British Columbia. A critical element of the infrastructure that many people don't think about is the mooring system that holds these buoys and their sensor payloads in place in winds that have reached 60 knots

and seas that have reached 15 metres. The rope, chain, anchors and shackles that keep these buoys and their sensors in place may not be very sexy, but they are critical parts of the technology that is SmartBay. Boats in the bay are also part of the infrastructure (this is unique) and carry AIS (mentioned earlier) and electronic chart systems. In addition, we are in the process of equipping these same boats with weather stations so that they can collect and provide meteorological and oceanographic data as 'vessels of opportunity' (Figure 2). A member of the CTec team affectionately refers to this as 'voodoo' (vessels of opportunity doing ocean observation). Satellite and radio communications are used to ship the sensor data to shore where meteorologists and oceanographers at AMEC Environment and Infrastructure use it to prepare detailed weather and sea state models and forecasts. The last, but most important step in the process is to post the data and information to the world wide web where it can be accessed by anyone with a smartphone or computer, and archived for future analysis.

The SmartBay web interface has been engineered by Earth Information Technologies to be simple to use – 3 clicks or less to get to the information that you need. All of the complexity of the infrastructure – sensors and buoys and moorings, communications and complicated models – are hidden from the user. This is an important aspect of 'infrastructure' – that the complex underlying technology is 'invisible' to the user. Think of, for example, your smart phone. How it works is not something you need to know. All you want to know is that it does and does it effectively.

In 2012 CTec signed a contract with the provincial and federal governments to expand and enhance SmartBay. This will result in application of the SmartBay concept to a number of 'SmartPorts' including Port aux Basques, Corner Brook, St. John's, and Lewisporte (Figure 3).

Each SmartPort will entail a suite of technology and information services to support precise navigation - the assumption being that larger and more numerous vessels will continue to test the limits of existing ports. Since port expansion is exceedingly expensive, precise navigation is key to accommodating increasing numbers of larger vessels without compromising safety. Like SmartBay, each SmartPort will begin with high resolution multibeam sonar mapping. This mapping will be continuous up to and beyond the shoreline, at a level of precision and detail that is so far unsurpassed. This detailed dataset will form the foundation of a precise navigation information package available for each SmartPort, providing exact depth information in support of enhanced decision-making.

Layered on top of the foundation of multibeam data, each SmartPort will be instrumented with tide gauges, wind and current sensors and meteorological instruments (weather stations) to provide realtime monitoring of dynamic environmental parameters. In addition, we will carry out high resolution mapping of the above-water areas adjacent to the port using a scanning laser system. Users of the SmartPort will have realtime access to this detailed suite of data via the SmartBay web site. Wind, current and tidal information in particular are very valuable decision making inputs when considering precise navigation of a large vessel in a restricted harbour. Combining precise water depth information for the full extent of the port with equally precise real-time data for local winds, currents and tidal levels will result in an enhanced level of confidence when manoeuvring larger and more numerous vessels in confined quarters. This will effectively increase the operating capacity of each SmartPort without actually increasing the physical size of the port.

SmartAtlantic

The operational benefits associated with the concept of 'better information…better decisions' has not gone unnoticed. CTec is partnering with the Canadian Marine Pilots Association (Atlantic) and Halifax Marine Research Institute (HMRI) to expand the SmartBay footprint in Atlantic Canada. This initiative will see deployment of a met/ocean buoy off Halifax harbour in

Figure 3: Deployment of a SmartBay buoy by the Canadian Coast Guard vessel *Earl Grey* off Port aux Basques, NL. The cloud of dust is kicked up by the mooring chain playing out over the rail of the ship.

support of pilotage operations. Recognizing the operational efficiencies and potential collaboration and expansion opportunities presented, CTec and HMRI will bring together the SmartBay and Halifax initiatives under a new and exciting 'SmartAtlantic' banner that will form the initial stage of a cooperative Atlantic Canada applied ocean observation system.

The key to the success of SmartAtlantic, as it has been for SmartBay, will be to build the system around local needs, but to international standards. Mariners, after all, are global creatures. SmartBay and SmartAtlantic are but two of a number of similar initiatives that are ongoing all along the eastern seaboard of North America, and beyond. SmartBay has been an active contributor to the Open Geospatial Consortium (OGC) Sensor Web North American sensor interoperability project – there are currently over 1400 sensor platforms reporting as part of this initiative - and also contributes data to the Northeastern Regional Association of Coastal Ocean Observation Systems (NERACOOS). By virtue of these linkages SmartBay and SmartAtlantic will be active participants in efforts to build the Global Earth Observing System of Systems. In addition, the Centre for Applied Ocean Technology, Monterey Bay Aquarium Research Institute (MBARI), the Open Geospatial Consortium and several of the major oceanographic equipment manufacturers have joined forces to establish the Smart Ocean Sensors Consortium – a group that is committed to the development and implementation of data and interface standards that will simplify a 'plug and play' approach to ocean monitoring.

If we had to sum up what we do and why we do it in 10 words or less, it would be the phrase 'better information…better decisions.' In the end, our objective is to provide all mariners with complete situational awareness of what is below them and around them at all times, along with a forecast of what to anticipate.

Bill Carter is Assistant Director of the Centre for Applied Ocean Technology, with primary responsibility for applied research in ocean observation. He is a graduate of Memorial University with a B.Sc. in Geography, and has worked offshore Newfoundland and Labrador in various capacities since 1983, including numerous offshore geophysical surveys for the Newfoundland Oceans Research and Development Corporation (NORDCO).

Randy Gillespie is the Director of the Centre for Applied Ocean Technology. He holds an M.Sc. in Earth Science from Memorial University and began his career as a marine geologist working on numerous offshore geophysical surveys on the eastern Canadian shelf. He is a registered professional geoscientist with the Professional Engineers and Geoscientists of Newfoundland and Labrador, past president of the Canadian Institute of Geomatics and past member of the advisory board for the Government of Canada's GeoConnections program.