PHP From the Shop Floor

Bringing Environmental Monitoring to the Internet

by Elizabeth Naramore

As PHP’s influence continues to expand in the web development industry, developers are discovering that it can solve a multitude of diverse problems. This is the first in a series of new articles that aims to provide real-world examples of ways in which PHP is effectively being used. In this issue, you will meet two gentlemen that have taken scores of geological, environmental and ecological data and organized it into an interface useful enough for scientists and non-scientists alike.

Introduction
I had the distinct pleasure of meeting with Dr. Kent Lindquist, President of Lindquist Consulting, Fairbanks, Alaska and Dr. Robert Newman from the University of California, San Diego. Together they have developed a system for aggregating a multitude of environmental and ecological data into a readable, usable format that can be analyzed and utilized by virtually anyone.

Lindquist Consulting has a very specialized niche market, bridging the gap between the science of environmental monitoring and the cyber-infrastructure required to manage the massive amounts of collected data. Their contracts typically range from computer and software training to capability expansion to IT research.

Background of ROADNet
In this particular case, Lindquist Consulting was hired several years ago by the University of California-San Diego, to assist with one of their largest projects, called ROADNet (Realtime Observatories, Applications, and Data management Network). Although industries like automated earthquake and oceanographic monitoring are comparatively mature, ROADNet is one of the first of its kind to take that automated data and make it easily accessible to an end user in a near-real-time manner.

ROADNet [1] is the result of a collaborative effort between the National Science Foundation (NSF), the Office of Naval Research (ONR), the Center for Earth Observations and Applications (CEOA), Calit2 (created by the California Institutes for Science and Innovation), Scripps Institution of Oceanography, San Diego State University, the Institute of Geophysics and Planetary Physics (IGPP), and the San Diego Supercomputer Center (SDSC).

Figure 1: The ROADNet Web Site
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Whether it is funding, information or access to massive amounts of computer power, each of these entities has a hand in the deployment of ROADNet. As the site states, “ROADNet will enhance our capacity to monitor and respond to changes in our environment by developing both the wireless networks and the integrated, seamless, and transparent information management system that will deliver seismic, oceanographic, hydrological, ecological, and physical data to a variety of end users in real-time.”

“Kent and Rob say they really looked no further than PHP to solve their dilemmas, mainly because of the extensive libraries available, and the ease with which functionality can be added to the web interface. They really like the open architecture of PHP, and the fact that you can get fully functional web applications deployed rapidly. Kent and Rob also appreciate PHP’s great support community.”

ROADNet’s purpose is to take data such as real-time images and readings from a variety of sensors, cameras, and the like and hand it to the end user on a silver platter. Easier said than done, in many cases.

There exists a commercial relational database system that is optimized for near-real-time monitoring applications called the Antelope Environmental Monitoring System from Boulder Real-Time Technologies, Inc. [2]. The Antelope User Group maintains a separate home page [2] with access to contributed source code. Its purpose is to aggregate the data from sensors from a variety of environmental monitoring sources such as global research vessels and ecological preserves, and bring them all together in one central data dumping ground. One example of these sources is the collection of stationary cameras spread throughout San Diego County that are owned and operated by HPWREN (High Performance Wireless Research and Engineering Network). These cameras are watching various locations, such as the SDSU Santa Margarita Ecological Reserve, the Mount Woodson and Mount Laguna Observatory, the La Jolla coast, and the California Wolf Center, among others. These real-time images captured by the cameras are transmitted to the San Diego Supercomputer Center, and stored in Antelope’s Datascope Relational Database as data. ROADNet then accesses this data and makes it available to the general public.

Cool ROADNet Features

Through their Real-Time Image Bank, ROADNet offers thumbnail and full-sized movies of the images captured by the cameras, which are created on the fly with PHP using the GD library. HPWREN is only one source out of many that provide data accessed by ROADNet. Other sources include Scripps Institution of Oceanography, Southern California Coastal Ocean Observing System, and Santa Margarita Ecological Reserve. Near-real-time images captured by all of these different entities’ cameras are available on the ROADNet site, and through one central web interface, with these interactive movies available for most.

By taking advantage of these diverse sources of information, ROADNet’s use in a practical application not only ranged from the San Diego Fire Department, using it to keep tabs on spreading wildfires and track their migration, but extended all the way to groups of surfers using it to monitor wave conditions, effectively allowing them to capitalize on the optimal surfing moment. Personally, I thought it was awesome to be able to see a near-real-time Pacific Coast sunset from my measly computer here in Cincinnati, Ohio. The image bank is on its third major revision and is continually being upgraded and enhanced.

ROADNet also offers hard data, which is graphed nicely for you on the fly, using PHP. In the “Time Series Data” section of the site [4], access is provided for a multitude of environmental variables including barometric pressure, humidity, temperature, rainfall, UV and solar radiation levels, and wind direction and speed, among
numerous other variables available. This data is collected from hundreds of sensors. You can see a graphical representation of changing levels for these variables for the past 24 or 48 hours or the past seven days. Or if you’d rather, you can see what’s happened in the last five minutes. Even better, you can choose the days and times of the range you want to see. You can also decide how you want the data presented back to you, whether it is a line graph or an XML file. As well, you can compare up to three datasets at one time. Not too shabby.

Kent tells me that they have big plans for ROADNet in the future. Future improvements include “better personalized interaction for each web user, ability to do sophisticated searches for particular data of interest, better support for real-time status monitoring of the deployed sensor networks, and more.”

**ROADNet as a Collaboration**

Besides being a standalone project, ROADNet is also used in a collaborative manner by several other entities. One such example is the METOC/Geophysics Branch, Naval Air Systems Command Weapons Division of the US Navy. This group uses ROADNet as one of the sources in its interpolation of surface wind vectors and offshore surface winds off the coast of Southern California. This information is archived and openly available [5].

Another of ROADNet’s collaborations involves the monitoring of the deep structure of the earth’s plates all the way down to the core. Funded by the NSF (National Science Foundation), this project aims to merge real-time earthquake monitoring tools with real-time seismic data, in order to provide a visual display of waveform data back to the end user. Earthscope is comprised of three components; the San Andreas Fault Observatory at Depth (monitoring fault zones), the Plate Boundary Observatory (monitoring plate-boundary deformation), and USArray (monitoring seismic activity across the United States). You can read more about the integration of these three components in detail at the Earthscope project web site [6]. ROADNet is a critical contributor to the Plate Boundary Observatory and USArray components of the entire Earthscope project, which you can see in greater detail at the Earthscope ANF web site [7]. This is a 12-year experiment currently in its second year, with the number of stations expanding from 100 to 400 by the project’s end.

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**The Case for PHP**

There were three challenges that faced Kent and Rob, as lead developers on the projects. The first was in accessing the specialized data being stored in Antelope’s relational database system and bringing it to a common platform that could be accessed by something like PHP. Secondly, they were dealing with roughly 1G of data each day that had to be processed, accessed and archived. Thirdly, they needed to find a way to collect this large amount of specialized data and make it accessible to the end user, taking into account cross-browser compatibility, multiple libraries needed, and several different architectures supporting the entire system. Thankfully, PHP made the development of such ambitious projects realistic.

Kent had a background in C, PERL and Tcl and Rob came from Coldfusion and ASP. They told me they really looked no further than PHP to solve their dilemmas, mainly because of the extensive libraries available, and the ease with which functionality can be added to the web interface.

Kent needed a way to access the data held in Antelope, and so he was forced to write his own PHP Zend extension for this purpose (which is now available in the Antelope contributed-code repository at http://www.indiana.edu/~aug). Several years ago, when Kent set off on this extension-writing adventure, educational resources were unfortunately sparse. As PHP matures and extension writing is more prevalent in the general PHP community, Kent is finding a
greater resource among fellow developers. As Kent states, “putting in C-level code for object support is an art known to few.” But he admits that that number is growing, making it easier to bounce ideas off others.

Regarding scalability, it pays to have a few friends on your side, as Rob and Kent know first hand. The ROADNet project has access to the San Diego Supercomputer Center for its data storage. Kent states, “all of our real-time systems use a data-transport grid system that is composed of semi-independent nodes, called ‘orbservers’, which makes it inherently scalable. We can put small databases at each node for short-term buffering, and are addressing large-scale distributed archiving and redistribution by linking to projects such as the Storage Resource Broker from San Diego Supercomputer Center. Regarding the PHP applications themselves, we have not yet hit scaling problems with the data-serving; however, a replicated-server system may become necessary at some point.” You can get a visual representation of their interaction of these “orbservers” at the ROADNet site (ROADNet Data Transport Topology in Realtime).

Rob is responsible for building web-accessibility and interactivity on the site itself. To accomplish this task, he uses tools such as the GD library to create near-real-time movies of the images captured, JPGraph [8], PEAR::Calendar [9] for providing online calendars and an online calendar tracking system that checks data health, and PEAR::Mail_Mime [10] to decode e-mail attachments that come directly from the Datascope database. His biggest challenge is getting everything to work together and play nice. As he states, “there are many pieces of the puzzle that have to fit together, such as installing the extensions in the correct place, modifying php.ini in several places to use our custom architecture, and writing secure applications.”

Their coding environment is simple: Kent and Rob both take the old-school approach to text editors, with Kent using vi and Rob using Vim. “IDEs are nice,” Kent says, “but when it gets right down to it for me, nothing beats a good text editor.” They are currently using both PHP4 and PHP 5 on beta servers and will eventually be switching over to PHP 5 exclusively because of the OOP features. For version control, they are using CVS on this project, although Rob states he is moving towards using Subversion for some other projects he is working on.

They really like the open architecture of PHP, and the fact that you can get fully functional web applications deployed rapidly. Although they have completed similar projects in the past, with PHP, they found deployment simpler and much quicker. “Other languages are challenging to put together, and they require a lot of coding,” says Rob. “But with PHP, a lot of people, mostly end users, can add to the system and can focus on the scientific problems without having a computer science degree.”

They agree that PHP makes data accessible in as many ways as possible. As well, by using sessions and cookies, users are given a richer web experience and can manipulate the data based on their preferences and their needs.

Kent and Rob also appreciate PHP’s great support community. With their backgrounds mainly in science as opposed to web development, they may not always know the right jargon to use, but most of the time, fellow developers are able to decipher any questions and are more than willing to help out.

When I asked them if they had any advice for a company or individual new to PHP or thinking about making the switch to PHP, they immediately said “Try it, it’s fun!” They emphasize that it can be done without a computer science degree, especially if you have experience with another programming language. And even if you are stuck at the basics, there are so many resources available that you won’t likely be stuck there for any great length of time. They definitely plan on sticking with PHP for future projects.

Kent and Rob presented their groundbreaking ROADNet project at the American Geophysical Union Conference in San Francisco in December of 2005.

**Summing it Up**

As you can see, PHP can be used for much more than writing a simple blog or CMS. With a little elbow grease and know-how (and of course the awesomely supportive PHP community), robust applications can be developed that serve a wide variety of real-world purposes.
If you have an interesting PHP development project you think would make a great addition to our “PHP From the Shop Floor” series, please don’t hesitate to contact me at elizabeth@naramore.net.

*Elizabeth Naramore has been working in web development since 1997, and PHP specifically since 2002. Although her main focus is in e-commerce, she has also co-authored several PHP related titles. Besides web development, Elizabeth also teaches e-commerce and writes a weekly PHP news column for PHPBuilder.com. She also enjoys being an active part of the mighty OINK-PUG (Ohio, Indiana, Northern Kentucky PHP Users Group). She lives in Cincinnati, Ohio, with her husband and two children.*

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**Resources & References**

1. ROADNet
3. Antelope User Group home page
4. Time Series Data
6. The Earthscope project web site
7. Earthscope ANF web site
8. JGraph
9. PEAR::Calendar
10. PEAR::Mail_Mime

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**Questions & Comments**

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