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Beacon Institute and IBM Team to Pioneer River Observatory Network

*IBM to Provide Breakthrough Stream Computing System for Real-Time
Environmental Monitoring*

Beacon, NY and Armonk, NY – In a unique collaboration with the potential for far-reaching consequences for environmental research and policy, The Beacon Institute and IBM today announced a plan to create the first technology-based monitoring and forecasting network for a major American river and estuary.

The **River and Estuary Observatory Network (REON)** will allow for minute-to-minute monitoring of New York's Hudson River via an integrated network of sensors, robotics and computational technology distributed throughout the 315-mile river. Once completed, the Institute and IBM anticipate that the network will be replicated on other river systems.

The first of its kind project is made possible in part by IBM's "Stream Computing" system, a fundamentally new computer architecture that can examine thousands of information sources to help scientists better understand what is happening in the world – as it happens.

"Imagine predicting environmental impacts the way we forecast and report the weather," said John Cronin, Director and Chief Executive Officer of The Beacon Institute. "With that technological capability we can better understand the effects of global warming, the movements of migrating fish or the transport of pollutants. The implications for decision-making and education are staggering."

In accordance with the collaboration, IBM will be developing an advanced sensor network that will capture data streams and conduct advanced data analysis in real time. The IBM Stream Computing system can capture data from a multitude of sensors that measure temperature, salinity, dissolved oxygen and pollution loading; map fish populations via acoustical data; and track particular fish species through radio "tagging."

"This is an ambitious initiative that will require substantial innovations in the methods by which environmental data are collected, interpreted and distributed," said Anthony Yu, Vice President, Semiconductor and Emerging Industries, IBM. "The development of a river observatory network is a technological frontier for science, engineering and policy. Once achieved, it can have applications for rivers worldwide."

"Real-time monitoring technologies currently used in ocean observatories allow us to observe physical, chemical and biological phenomena at multiple scales – from the micro to the macro – both spatially and over time. Never before has there been a way of doing science that allows us to observe multiple scales at once," said Arthur C. Sanderson, Ph.D., Professor of Electrical, Computer and System Engineering at Rensselaer Polytechnic Institute and Senior Science Advisor for The Beacon Institute. "From this data, we can build scientific models to understand how changes in chemistry and biology affect the fish and the river, and by extension, the larger scale ecology."

"The Hudson River is the pilot river system for this groundbreaking initiative, and the 12 million people who live within its watershed will be the first beneficiaries of our work," said Cronin. "This collaboration between IBM and The Beacon Institute is vitally important to our plans in progress for a \$40 million research laboratory at Denning's Point in Beacon, thanks to funding through New York State."

When completed, this laboratory, titled the Center for Advanced Environmental Technology and designed with IBM participation, will serve as the physical home for the expert team of engineers, scientists, policymakers and educators from the commercial, academic, government and not-for-profit sectors working on the River and Estuary Observatory Network.

A team of IBM engineers and scientists will work on the REON collaboration, and will have access to IBM's extensive analytical and computational resources from the IBM Watson Research Lab. IBM's Global Engineering Solutions team will execute the fundamental design elements such as the complex sensor network and distributed computational platforms. Additional elements of the collaboration include a postdoctoral fellowship to cultivate early career talent. The Beacon Institute and IBM also plan to host an international conference in the Hudson River valley regarding rivers, estuaries and technology and will seek out, as appropriate, opportunities to work with public school education and outreach programs for children gifted in science and engineering.

Key academic and governmental participants include Rensselaer Polytechnic Institute, Lamont-Doherty Earth Observatory at Columbia University, Wood's Hole Oceanographic Institution, Union College, Stony Brook University, Pace Law School, Rutgers University Coastal Observation Laboratory, National Marine Fisheries Service and others.

"Although the Hudson River won't flow any faster as a result of this project, the speed at which we can access, analyze and interpret data coming from the river and its watershed will increase by many orders of magnitude with the inception of the River and Estuary Observatory Network," said W. Rockwell "Rocky" Geyer, Ph.D., Senior Scientist and Chairman of the Applied Ocean Physics & Engineering Department at Wood's Hole Oceanographic Institution (WHOI) and Project Advisor for The Beacon Institute/WHOI Postdoctorate Program. "This project provides a dynamic synergy between computational technology, environmental sensing and environmental science, providing a new way of studying, understanding and managing a valuable natural system."

"This flagship collaboration between IBM and The Beacon Institute and its partners is a perfect example of how the business world and not-for-profit research organizations can join together to create and implement innovative technology solutions for tremendous impact both at home and in developing countries," said John C. Cavalier, retired Chairman of MapInfo Corporation and a member of The Beacon Institute's Board of Directors.

Cronin concluded, "This new way of observing, understanding and predicting how large river and estuary ecosystems work ultimately will allow us to translate that knowledge into better policy, management and education for the Hudson River and for rivers and estuaries worldwide."

About The Beacon Institute:

The Beacon Institute, headquartered in the City of Beacon in Dutchess County, New York, is a powerful nexus for interdisciplinary research, policy-making and education regarding rivers, estuaries and their connection with society. Its programmatic initiatives engage scientists, engineers, educators and policy experts in collaborative work focusing on some of the most important and endangered bodies of water in the world. It also aims to make the Hudson Valley a global center for the development of replicable advanced monitoring and observation technologies for rivers and estuaries. www.thebeaconinstitute.org

To learn more about the power of Stream Computing, view a webcast of Kevin Pleiter of IBM's Financial Services Team and Nagui Halim, IBM Research [here](#).

<http://www.youtube.com/watch?v=mri7cha8ziw>

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Sidebar

River and Estuary Observatory Network (REON) *Visualizing the Unseen River*

Beneath the calm surface of the Hudson River lies an invisible, vibrant and dynamic world. From salt water to fresh, silt to sand, this diverse and fragile ecosystem is a critical source of fresh water, food, transportation, recreation and cultural beauty for the 12 million people who live within its watershed.

But do we know enough about this invisible world to protect it?

"The integration of science, technology and policy remains one of the great, unresolved challenges of contemporary environmentalism," says John Cronin, Director and Chief Executive Officer of The Beacon Institute. "The task of the 20th century was to raise public awareness of environmental issues and address a century-old legacy of environmental abuses that plagued land, air and water. The challenge of the 21st century is to create the innovations that will harmonize the daily activities of the human community with the continuing needs of the local and global environment."

River and Estuary Observatory Network (REON)

Visualizing the Unseen River (con't.)

This is the promise of the River and Estuary Observatory Network (REON), a pioneering initiative between The Beacon Institute and IBM with the potential for far-reaching implications.

"This collaboration between The Beacon Institute and IBM will create a large-scale river 'observatory' using real-time monitoring technologies currently being used in the study of oceans," says Arthur C. Sanderson, Ph.D., Senior Science Advisor for The Beacon Institute and Professor of Electrical, Computer and System Engineering at Rensselaer Polytechnic Institute.

"With the expertise of IBM and academic and government partners, we are taking that concept several steps further. REON will be a first-of-its-kind information infrastructure that can collect, sort, analyze and graphically portray information from continuous streams of real-time physical, chemical and biological data from hundreds, possibly thousands, of sensors that would be installed in the Hudson River."

Real-time monitoring and observation technologies provide new ways of looking at phenomena at multiple levels of resolution. "Scientists used to have to fill up a bottle, bring it back to the lab for analysis, and then repeat that activity enough times to get a data set," explains Sanderson. "We would like to have the ability to continuously monitor activity from the microscopic to macroscopic scale, and build scientific models to understand how changes in the chemistry and biology affect the fish, river and larger ecology."

Sanderson explains the multi-scale concept. "At the microscopic scale we see biological cells and chemicals. At the meso scale, we see water flowing, fish swimming and plants growing. At the macro scale, we see 315 miles of river and its watershed, with the Adirondacks at one end and New York City at the other." On the temporal scale, scientists can observe phenomena that occur in micro- or milliseconds or over seconds, minutes and hours, as well as broader ecosystem changes that occur over years, decades and centuries.

The data collection backbone of REON will be a distributed computing network composed of multiple types of advanced environmental sensors, each sensor with its own computer chip. Adding inexpensive and power-efficient communications systems to each sensor is like giving each sensor a cell phone to transmit its data. A networked array of sensors in the river, perhaps one every 100 meters, will provide the data necessary to locally observe spatial variations in such variables as temperature, pressure, salinity, turbidity (water "cloudiness"), dissolved oxygen and other basic water chemistry parameters.

New sensor prototypes use optical properties to understand biological characteristics such as chlorophyll distributions. Acoustic imaging techniques are used to map the river bottom and will be able to characterize the sediment types. High resolution acoustic imaging will be used to find biological organisms. In the future, *in situ* ("in place") microscopy could identify organisms from images, and genetic sequencing instruments could identify biological organisms by their DNA/RNA sequences.

"New generations of sensors will measure specific physical, chemical and biological variables with great sensitivity. The measurement of dissolved oxygen in the Hudson River on a continuous time basis will tell us how a local region of the river may be able to support biological organisms. When changes occur—for example as contaminants are introduced, biological species migrate, agricultural nutrients accumulate or water is heated during power generation—

River and Estuary Observatory Network (REON)

Visualizing the Unseen River (con't.)

these interactions may affect dissolved oxygen and the sustainability of that region of the river," Sanderson explains.

All of these sensors transmitting information in real-time will result in massive amounts of data. Collecting, processing and making sense of that much data is perhaps one of the greatest challenges in implementing REON.

Enter IBM. REON will be the first public implementation of IBM's recently introduced Stream Computing system. Four years in development, this high-performance computer system rapidly analyzes data as it streams in from many sources, increasing the speed and accuracy of decision making.

"The hardware and software that exist today are not suited for real-time analysis of data. Instead they were built to pause life, query a database of information of things that happened in the past and provide an answer, even while important new information is still coming in," explains Sharon Nunes, IBM's Vice President of Strategic Growth Initiatives, Big Green Innovations. "Our Stream Computing system combines a fundamentally new architecture with breakthrough mathematical algorithms to create a forward-looking analysis of data from any source – narrowing down data to meet user queries, and then continuously refining the answer as additional data becomes available. This system's ability to analyze information as it happens has very powerful applications for environmental science, financial services, government, astronomy, traffic control, healthcare and many other scientific and business areas."

The new computer system has the ability to assemble applications on the fly based on the inquiry it is trying to solve, using a new software architecture that pulls in the components it needs to make tailored information available to a variety of end-users – from researchers, to teachers and schoolchildren, to policymakers and the general public.

Applications of REON data could include the ability to visualize the movement of chemical contaminants, monitor drinking water quality and protect fish species as they migrate, as well as provide a better scientific understanding of river and estuary ecosystems.

"This project provides a dynamic synergy between computational technology, environmental sensing and environmental science, providing a new way of studying, understanding and managing a valuable natural system," observes W. Rockwell "Rocky" Geyer, Ph.D., Senior Scientist and Chairman of the Applied Ocean Physics & Engineering Department at Wood's Hole Oceanographic Institution (WHOI) and Project Advisor for The Beacon Institute/WHOI Postdoctorate Program. "As a natural scientist, I am very excited to participate in a program that can transcend the arcane and esoteric details of our individual research projects to achieve a truly interdisciplinary synthesis of the natural and human-influenced dynamics of the Hudson River ecosystem."

Cronin concurs, "This new way of observing, understanding and predicting how large river and estuary ecosystems work ultimately will allow us to translate that knowledge into better policy, management and education for the Hudson River and for rivers and estuaries worldwide."

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