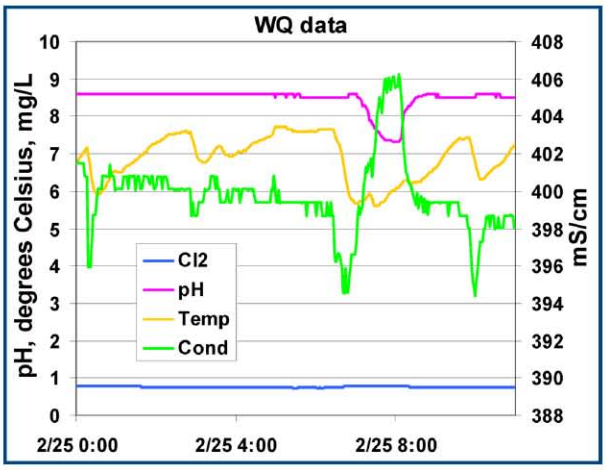
Computers and Information Sciences
Water Security



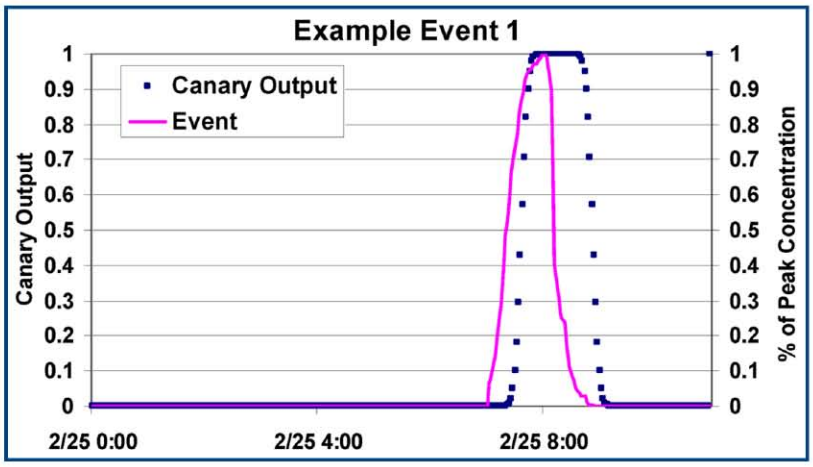


Figure 1: Canary software uses water sensor data (left) to detect contamination incidents (right), using water quality (WQ) parameters like chlorine levels (Cl_2), pH, temperature and turbidity (Cond).

Sandia Collaborates with the EPA to Develop Contaminant Warning Systems

Software deployed at several major water utilities

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A reliable, clean water supply is critical for maintenance of public health, protection of public infrastructure, and the normal operation of many industries. However, the distributed physical layout of drinking water systems makes them inherently vulnerable to contamination with deadly agents, resulting in potentially catastrophic numbers of illnesses or casualties. Sandia is currently partnering with the Threat Assessment Vulnerability Program (TEVA), within the Environmental Protection Agency's (EPA's) National Homeland Security Research Center, to develop contaminant warning systems (CWSs) for the protection of water supplies. A CWS uses sensors to monitor water quality and provide early detection of chemical or biological contaminants.

Sandia researchers have developed mathematical algorithms and software to address several CWS design challenges. Sandia's Canary software detects a change in water quality that indicates a contamination incident, using data from commercially-available sensors that measure water quality parameters like pH and turbidity (Figure 1). A key issue is that many contaminant-specific sensors are not commercially available. Another key issue is the placement of sensors in large water distribution networks. To solve the latter problem, Sandia's TEVA-SPOT Toolkit optimizes sensor locations to protect the largest possible population from a broad set of contamination incidents (Figure 2). New algorithms were developed for

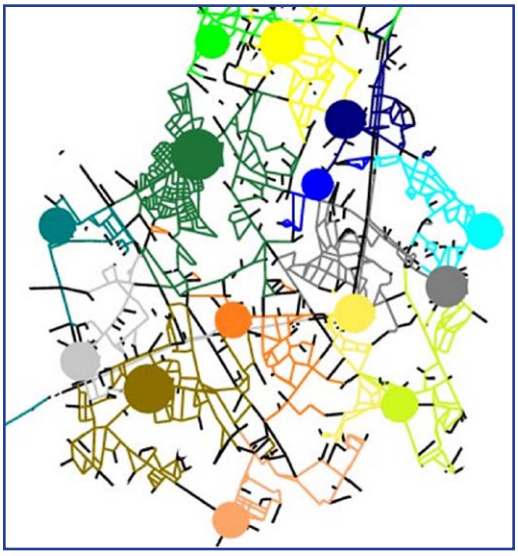

Figure 2: An example of how the TEVA-SPOT Toolkit optimizes sensors placements to simultaneously protect different subsets of a water distribution network.

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Canary and the TEVA-SPOT Toolkit to enable water utilities to analyze large-scale, noisy data sets. In particular, these algorithms are designed to work on commonly available computing resources so that authorities can determine sensor placement for a large network on a standard workstation.

The EPA's Water Security Initiative used these tools in a pilot study at the Greater Cincinnati Water Works. Canary has been deployed at 17 locations in their distribution network, where it is performing real-time detection. The EPA has also partnered with the American Water Works Association to design CWSs for seven other U.S. water utilities with large distribution networks. The sensor placements developed during these studies could significantly reduce potential health impacts. Moreover, an economic assessment predicts that these CWS designs could reduce economic impacts by billions of dollars.

Related Publications:

"Detecting Changes in Water Quality Data." S A McKenna, M P Wilson and K A Klise. *J. of the American Water Works Association*. (to appear)

"Impact of sensor detection limits on protecting water distribution systems from contamination events." S A McKenna, D B Hart and L Yarrington, *J. of Water Resources Planning and Management*. 132 (4), 2006. pp. 305-309.

"Sensor placement in municipal water networks with temporal integer programming models." J Berry, W E Hart, C E Phillips, J G Uber and J Watson. *J. Water Resources Planning and Management*. 132 (4). 2006. pp. 218-224.

"Robust optimization of contaminant sensor placement for community water systems." R Carr, H J Greenberg, W E Hart, G Konjevod, E Lauer, H Lin, T Morrison and C A Phillips. *Mathematical Programming Series B*. vol. 107. 2006. pp. 337-356.

"Sensor Placement in Municipal Water Networks." J Berry, L Fleischer, W E Hart, C A Phillips and J Watson. *J. Water Planning and Resources Management*. 131 (3). May 2005. pp. 237-243.

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