Position Paper for
Beyond SCADA: Networked Embedded Control for Cyber Physical Systems workshop

SCADA and GIS for drinking water distribution system monitoring and response: critical gaps

Shannon L. Isovitsch[1] and Jeanne M. VanBriesen[2]

SCADA is frequently used to manage and control drinking water treatment systems. In this application, SCADA systems perform remote monitoring and operations control along with data management and storage. SCADA systems often serve the joint purposes of operational information and regulatory compliance data management, The most important challenge in the advancement of SCADA systems in the drinking water industry is the need for monitoring and control throughout the distribution system, rather than only at the treatment plant and water sources.

This will require integrating existing SCADA systems with numerical distribution system models to enable better model calibration and demand estimation, simulation of past events for analysis, and simulation of emergency situations for response training. We anticipate this integration will highlight the need for spatial as well as temporal data storage and analysis through GIS, and the need for the expansion of SCADA systems to track water quality as well as quantity.

SCADA systems at a water utility are currently used to monitor flows and pressures at the treatment plant and associated water sources. Water quality monitoring is often performed by grab sampling to meet regulatory requirements. While grab sampling is useful in detecting contamination events with long-term consequences, it is not adequate for detecting short-term, intense contamination events.[1] Also, because of the resources needed to address high-priority facilities, little attention has been given to the vulnerabilities associated with the distribution system. Security challenges are more evident in the distribution system than anywhere else in water utility operations.[3] Expanding SCADA systems to retrieve, store, and control the water quality throughout the distribution system is needed.

Integration of real-time data collection with drinking water distribution models is necessary to enable rapid detection, evaluation, and response to intentional and accidental intrusions into the system. Distribution system models contain more pipes and nodes than the SCADA system has sensors; thus model prediction can be useful in interpolating SCADA observations between monitoring points as well as to extrapolate SCADA observation in the future.[2] One of the primary uses of a water distribution model is to predict the effect that an emergency will have on the system and quickly develop appropriate corrective action.

The overall goal of SCADA advancement in the drinking water industry over the next 5 to 10 years should be incorporation of the distribution system into current SCADA plant-centric systems, and addition of real-time water quality sensing information to the water quantity information now archived. These goals will only be reachable through integration of SCADA,

distribution system water quality models, and GIS. The security of the nation's water supply requires these advances.

---

[1]Shannon Isovitsch is a graduate student in the Department of Civil and Environmental Engineering at Carnegie Mellon University. Ms. Isovitsch received her B.S. in Civil Engineering from Pennsylvania State University and her M.S. in Civil and Environmental Engineering from Carnegie Mellon University. She is a registered Professional Engineer in Pennsylvania and has over 7 years professional experience in the water resources field. Her research interests are in drinking water system modeling and data management. Additional details of her research areas and work experience as well as her full curriculum vitae can be accessed at http://www.ce.cmu.edu/~sisovits/. Email: sisovits@andrew.cmu.edu Tel: (412) 268-3023

[2]Jeanne VanBriesen is Associate Professor in the Department of Civil and Environmental Engineering at Carnegie Mellon University and co-director of the Water Quality in Urban Environmental Systems Center (WATER QUEST). Dr. VanBriesen received her B.S. in Chemistry and Secondary Education and her M.S. and Ph.D. in Environmental Engineering from Northwestern University. She is the recipient of the ARCS Fellowship, the National Science Foundation Career Award, the Ladd Award, and the Paul and Norene Christiano Faculty Fellowship. Her research interests are in biodegradation of recalcitrant organic compounds, drinking water system sensor deployments and modeling, and thermodynamics for modeling bacterial systems. Dr. VanBriesen is the author of numerous journal articles and has given many presentations on a wide range of subjects. Additional details of her research areas and related publications as well as her full curriculum vitae can be accessed at http://www.ce.cmu.edu/~jeanne/. Email: jeanne@cmu.edu Tel: (412) 268-4603

Reference List

1. American Society of Civil Engineers, American Water Works Association and Water Environment Federation. *Interim Voluntary Guidelines for Designing an Online Contaminant Monitoring System*, American Society of Civil Engineers, 2004.

2. Joshi, Pranam , Tom Walski, Sudhir Gandhi, Jeffrey A. Andrews, and Carl F. Newswanger. "Case Study: Linking Bristol Babcock's SCADA Systems to WaterCAD, a Water Distribution Modeling Tool." *2004 American Water Works Association DSS Conference*.

3. Murphy, Brian M., and Gregory J. Kirmeyer. "Developing a Phased Distribution System, Security Enhancement Program." *Journal American Water Works Association* (2005): 93-103.