Good literature review on smart water networks (swan) - water quality

Business, Management

Smart water networks take advantage of real time data, pumps and other essential distribution points to automate the process control schedules and support real time operations decisions. It is well understood that the drivers for smart water networks is not resistible. There is a compelling need to develop smart water and energy efficient systems that are at par with the rising demand and the diminishing water resources. The fact that infrastructures are rapidly deteriorating and the fact that water loss and leakage are relentless means that there is a need for intelligent systems that would detect, report, and prevent associated water problems at increasing rates. Although water conservation and management practices are evolving, the global concerns are fueling a move to smart water systems that are efficient, sustainable and affordable.

Technological advancement in smart water networks is aiding water utilities in boosting their operations to ensure water efficiency and safety. This paper seeks to explore some of the literature on the current state of the SWT. It will also explore the experiences of water utilities in using early warning systems and source tracing. Finally, the paper will explore the potential and challenges in implementing these technologies and the way forward in enhancing water quality management in water distribution networks in enhancing water security.

Literature review

A number of literatures have been written concerning smart water networks. A paper by Murray (2011) is motivated by terrorist incidences and develops a model for securing water networks. Terrorist activities have become a federal, local and global concern and have attracted the attention of most

parties. The United States Environmental Protection Agency has taken initiatives to ensure safe private and public water utilities. The works of Murray (2004) and Ostfeld, (2006) advanced the methods of mitigating contamination threats to drinking water. The authors developed the Contamination Warning Systems as a way of mitigating accidental and intentional contamination. With this CWS, there are multiple approaches of monitoring water safety including water quality sensors placed along distribution systems, public health surveillance systems and customer complaint monitoring programs.

There have been systems that have been developed to ensure that there is monitoring of the water systems. Event detections that have been seen to be useful in the water system include CANARY which have been useful in monitoring the quality of the water from different points. The systems will report on any anomalies that are detected on the water. CANARY are posed to be able to provide the system with important information that are useful in the management and monitoring of the water.

Another system that has been useful in this aspect is the Program for Online Network Inversion (PONI). It is a system that is useful in the management of the contamination of water system. It will show the source of the contamination in a water network. It utilizes large-scale optimization means to detect the exact locations where there has been contamination.

A research project titled Threat Ensemble Vulnerability Assessment TEVA forwarded by EPA with collaboration with Sandia National Library, the University of Cincinnati and Argonne National Library developed a set of design tools that helped the development of sensor networks. A Threat

Ensemble Vulnerability Assessment framework was developed that supported the six basic vulnerability assessment elements of incident simulation, consequence assessment and threat mitigation analysis.

Contamination Warning Systems

According to Robertson & Morley, CWS is intended for surveillance and monitoring of water systems to provide early alerts and awareness on impending threats. The author identifies a number of contamination warning indicators. They include security breaches in private/public water holding systems, witness accounts, and public health notifications. Also included are notification by perpetrators, notification by law enforcement agencies, notification by news media, unusual water quality and customer complaints. The authors echo the works of other authors such as Murray (2010) which identifies three characteristics of CWS: detect to protect, detect to warn and detect to treat. Given the danger posed by terrorist activities and other insecurity incidences, detect to protect is the most viable option in protecting the safety of water systems.

Source Tracing

EPANET is a simulation program developed to measure water quality behavior at specific points in the network. The program works by tracking the flow of water in each tank, the concentration of chemical content, height of water in each tank and pressure at each node. The tool is designed to probe and understand the movement and fate of drinking water constituents along the distribution system and raise an alarm if need be. The tool works best in hydraulic model calibration, chlorine residual analysis, computer

exposure assessment and a range of other applications. According to EPA, EPANET is used to assess alternate management strategies for enhancing water quality throughout the system and runs on Windows platform. Specifically, it identifies alters source utilization within multiple source systems, pumping and tank filling schedules, use of satellite treatments such as chlorination and target pipe cleaning and replacement.

Experiences of water utilities in early warning systems with source tracing

Water contamination detection technologies are crucial in the management of water supply systems. Applications such as CANARY have the capability of analyzing water quality along distribution network using water quality variables. The systems are highly efficient in that it employs signal and trajectory clustering logarithms to eliminate false positives that could trigger adverse consequences. Despite the huge steps taken in extending the use of the algorithms to the source location, questions of accuracy and reliability still emerge. Technology is a major partner in design and validation of contamination detection and prevention systems. Source identification is a lengthy process that requires a great deal of simulation of possible scenarios to be compared against previously simulated cases. It involves a wide range of new observations that in some cases may fail to tally. It has been the main cause of concern in the determination of flow conditions using simulated cases.

Potential/challenges in implementing water-based technologies

Given the intensity of security threats on a local, federal and global basis, water-based technologies have converged. The convergence has reached systems that reduce the time between the detection of a contamination incident and implementation of responses that mitigate the incident. CWS have provided a means of detecting contamination attempts that would not be possible in their absence. Hence, it is a proactive approach that utilizes monitoring and surveillance technologies to collect, analyze and communicate information in near real time of potential threats.

Inversely, the challenges faced in the detection of water contaminants lies in the lack of data and data sharing mechanism. The lack of enough data and the type of data to be collected and shared in a timely manner is a real challenge. Currently, there is no central agency that deals with expedite sharing of water contamination intelligence. It undermines the positives achieved from technological breakthroughs.

Way forward

In spite the development of contamination warning systems, there are a number of issues that need to be solved in order to ensure the safety of the commodity. First and foremost, organizations have been struggling with the questions of appropriate technology, contaminants to monitor, location of sensors and ways of maintaining sensors in the network. Major among them is how to act on the information from the sensors by translating them into actionable data that can aid in decision making. Agencies such as EPA, DHS and others have made notable progress in securing water facilities but in

order to achieve more progress, two major initiatives are mandatory:

- Collaboration between concerned agencies to design, implements, test and evaluate contamination monitoring programs and technologies to the level that reportable and comparative performance can be achieved.
- Collaboration in design, evaluation, classification and distribution of sensitive security information that aids in the management of water safety. Currently, there is no such mechanism in place that gathers for the dissemination of accurate and timely information regarding water security.

References List

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