From manual to automated

Reducing costs and improving service in a Texas water municipality

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Harris County Water Control and Improvement District No. 1 (HCWCID) provides water and wastewater services to the community of Highlands, Texas, a town of approximately 8000 residents located east of Houston on the banks of the San Jacinto River.

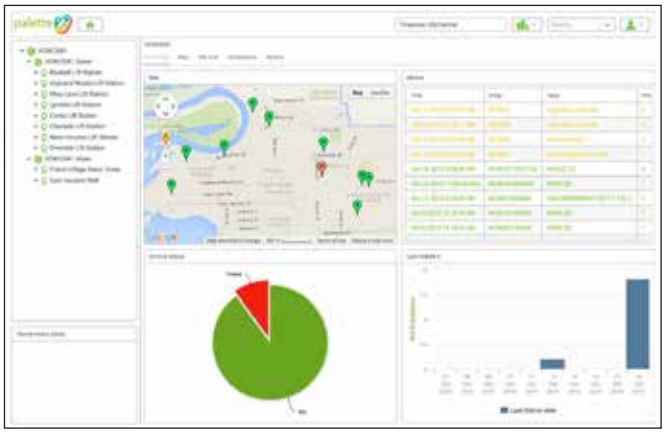
In 2014, HCWCID staff members embarked on several projects to introduce more automation into their operations. One of these projects sought to deploy a supervisory control and data acquisition (SCADA) system to provide remote monitoring and data collection at all operational sites.

Prior to the SCADA project, HCWCID relied on a traditional autodialer system to report critical alarm conditions, such as a chlorine leak. Staff members would visit each site daily to take manual readings of process parameters. This hand-recorded data then was kept in paper files in the district's main office.

SCADA as a service

Like many similar municipalities, HCWCID has a small number of key staff members. It has no IT department to manage the operation and maintenance of SCADA software and server equipment. So, the district chose a cloud-based solution, called "SCADA as a service" (SaaS) to minimize the effort required.

The benefits of SaaS for an organization like HCWCID are substantial. A third party performs configuration, monitoring, backup, and other system management activities. The shared infrastructure – the computer servers and software that run the SCADA – greatly reduces the cost to HCWCID and other users. The fixed annual costs covering all aspects of the service, which limits chances for equipment breakdown and replacement, help with the district's budgeting and planning.



◄ **Utility trucks in Harris County Water Control and Improvement District No. 1 are equipped with laptops, pictured at left, that connect to the district's SCADA system. These laptops enable operators to monitor system status, such as with the screen display (above), and view and download data from across the district.** Harris County Water Control and Improvement District No. 1

Harris County's only capital outlay was for the purchase of the remote telemetry units (RTUs). As these included cellular communications, there was no need to purchase or install additional equipment. The service provider preconfigured each site in the system prior to installation. Installation at each site involved connecting the RTU to the relevant sensors, taking typically 15 to 30 minutes, and requiring basic instrument-technician-level competency. Once complete, communication with the SaaS was established immediately. HCWCID pays a small annual fee per site to cover costs for the SaaS and cellular communications.

Replacing manual effort

With the new system in place, one of the manual tasks replaced was the collection of run data for pumps. Previously, to collect the data on how many hours the pumps had run required a visit to each site to inspect the clocks in the control panel. An operator recorded the cumulative number of hours and used this to determine a daily number of hours run. This method is time-consuming and prone to error.

In the automated system, a simple alternating-current sensing coil was fitted to each pump's live conductor. A digital signal indicating pump running or pump stopped is recorded, and this is used to compute automatically the number of hours run. In addition, the SCADA system can record the number of pump starts.

Simplifying the site deployment

The RTUs deployed on each site were battery powered and included a built-in cellular modem. A standard wiring arrangement was determined to suit any site configuration including

- depth sensors,
- level float switches,
- current sensing coils for main and standby pumps, and
- rain gauges.

This standard configuration simplified the wiring and allowed for the rapid deployment or exchange of equipment in the event of failure. Each site installation was very quick to complete, as it only required connection of the relevant sensors to the terminal block.

The use of cellular technology avoided the need for aerial mounting and alignment.

Because each site already had power, the RTUs were configured to use this as the primary power source and to switch over to battery backup if the main source failed. At the same time, an alarm would be sent to notify staff of the power failure.

Automating the alarm-notification process

In addition to the replacement of the existing autodialer system to report specific alarms, the new system now reports such conditions as

- water tower low level,
- water tower high level,
- wet well high level,
- power failure, and
- low battery.

A cloud-based alert-notification system sends alarms. This system provides a wide range of configurable options. It can report the condition via email, smartphone app, voice message, and/or short-message-service (SMS) or text message.

In addition, the notification system can be configured to create schedules to define rules for how to report the alarms. For instance, certain alarm conditions may not need to be reported during the working day but must be reported at night or on a weekend.

The system also can escalate a notification if no response is received. For instance, if an alert is reported via the smartphone app and no acknowledgement is received after a configurable time

A standard SCADA installation for the Harris County Water Control and Improvement District No. 1 includes a remote telemetry unit (RTU) – the grey cylinder with the orange base – installed in a control cabinet. The RTU takes up very little space and uses cellular technology to communicate with the cloud-based system. Harris County Water Control and Improvement District No. 1

Before the supervisory-control-and-data-acquisition (SCADA) system, traditional pump clocks, such as those pictured at left, required daily reading to determine the number of hours run. The new system uses a simple alternating current sensing coil, pictured at right, to provide a digital indication when the pump is running or stopped. The SCADA system then transmits this data to users via a cloud-based network. Harris County Water Control and Improvement District No. 1

period, the system can either send the message to a different person or via another method.

Supervisors can check on the status of notifications using the smartphone app at any time. Supervisors also can receive weekly emailed reports to show the response times to notifications to ensure reaction times are appropriate.

The notification system ensures that alarm conditions are reported to the right people, and supervisors can be assured that action is being taken as required.

Access everywhere

The final step in the automation process was to deploy cellular-enabled laptops in all HCWCID trucks. The laptops monitor the status of the SCADA system. (The laptops also monitor the status of the district's automated meter reading systems, which was installed as a part of the same push for automation as the SCADA system.) The information is available using standard Web browsers. As a result, no special software needs to be installed or maintained by HCWCID.

The SCADA view from the laptops shows the location and status of all RTUs. Users can easily navigate through the hierarchy to specific sites to view or download data.

The SCADA-as-a-service system that Harris County Water Control and Improvement District No. 1 installed enables alarms and notifications to be delivered via email, voice message, and text message, as well as with a smartphone app like the one pictured. Ops Genie

Addressing cybersecurity concerns

Cybersecurity is a major issue in all areas of society. Critical infrastructure organizations, such as water utilities, are at serious risk from such threats. A number of high-profile incidents on critical infrastructure have been reported, including one in 2000 in Australia where a disgruntled contractor deliberately manipulated a SCADA system to pump hundreds of thousands of gallons of untreated wastewater into rivers and other public places.

Cloud-based SCADA has come under scrutiny as presenting a major vulnerability for critical infrastructure organizations. There is no doubt that these systems should be considered and implemented carefully with cybersecurity in mind.

To minimize the security risks with cloud-based SCADA, considerations include the following:

- Ensure the system is used for read-only purposes, that is, no remote control is possible.
- Ensure RTUs have no output capability and are not connected to actuators.
- Use proprietary, unpublished, communications protocols between RTUs and the SCADA system, or use data encryption on the communications links.
- Ensure all Web-based communications use secure protocols and security certificates to validate the organizations involved.
- Operate continuous monitoring of cloud infrastructure to minimize downtime.

In addition, critical infrastructure organizations must enforce all recommended cyber-hygiene practices, such as controlling usernames and passwords, managing the use of removable media such as USB drives, maintaining antivirus protection and system updates, and so on.

Cybersecurity is a constant challenge, and there is no simple solution. Constant vigilance is required, but the above controls all reduce the risk of a cybersecurity problem.

Realizing the benefits

HCWCID's adoption of SCADA and, specifically SaaS, has introduced significant financial savings and improvements in its operations:

- The availability of site-status data has reduced the need for routine visits, which saves on fuel costs and vehicle wear and tear, as well as reducing operator exposure to site and travel risks.
- Staff members now have the time to be more proactive in their activities, providing a better service to their customers. Instead of visiting all sites each day to perform routine tasks such as recording data, operators can spend their time on preventive maintenance and process optimization such as identifying factors contributing to unaccounted water.
- Access to cumulative historic data allows HCWCID to make other efficiency savings such as adjusting pump run times to reduce energy usage.

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The authors wish to thank Metasphere (Surrey, England), Terzo Digital (Surrey, England), and OpsGenie (Falls Church, Va.) for their help with the project described.