Effective Data Management Enables Intelligent Utility Management

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UTILITY MANAGEMENT

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ABSTRACT: Instrumentation and automation play a vital role to managing the water industry. These systems generate vast amounts of data that must be effectively managed in order to enable intelligent decision making. Time series data management software, commonly known as data historians are used for collecting and managing real-time (time series) information. More advanced software solutions provide a data infrastructure or utility wide Operations Data Management System (ODMS) that stores, manages, calculates, displays, shares, and integrates data from multiple disparate automation and business systems that are used daily in water utilities. These ODMS solutions are proven and have the ability to manage data from smart water meters to the collaboration of data across third party corporations. This paper focuses on practical, utility successes in the water industry where utility managers are leveraging instantaneous access to data from proven, commercial off-the-shelf ODMS solutions to enable better real-time decision making. Successes include saving $600,000 / year in water loss control, safeguarding water quality, saving millions of dollars in energy management and asset management. Immediate opportunities exist to integrate the research being done in academia with these ODMS solutions in the field and to leverage these successes to utilities around the world.

KEYWORDS: Operations data management system, ODMS, real-time, decision support

INTRODUCTION

The water industry realizes the need for instrumentation, controls, and automation in order to better manage their facilities and operations. Utilities may implement and upgrade automation systems at various facilities at different times when funding is available which can lead to multiple vendor systems. In addition, information technology business systems to manage assets, financials, geospatial information, and laboratory information are also required to manage the overall business landscape. Adding new smart water metering systems increases the complexity as potentially, millions of streams of raw data need to be managed and used effectively for billing, water loss control, and pressure management. With the multitude of business and engineering systems, quickly accessing, integrating, and using the data in a meaningful way to make better business decisions can be very difficult, costly, and overwhelming. Having fast and easy, instantaneous access to real-time and historical time series data, decision makers are enabled to make informative decisions based on factual information.
In industry, these systems that manage time series operational data are typically known as data historians, however, there are varying options and capabilities from home grown systems to independent vendor commercial off the shelf (COTS) time series solutions. The most advanced systems are COTS, scalable and have the ability to manage and integrate operational and business data across the enterprise regardless of data source; these systems are referred to as Operations Data Management Systems (ODMS). ODMS not only manages time series data effectively, but also integrates seamlessly with relational, business data, see Figure 1. There are thousands of facilities in various industries worldwide effectively managing and leveraging their operational time series data for business using ODMS solutions. This paper discusses some of the successes of using ODMS at several water utilities around the world.

MATERIALS AND METHODS

Several issues arise when managing large volumes of time series data. First of all, data managers and users must understand and realize this real-time and historical process control data is time series data which consists of a date, timestamp, and value. This is critical as the appropriate technology should be used to handle and manage this data. Ie. A time series database solution is ideal for effectively managing large volumes of time series data, however, many users rely on relational database technologies which leads to poor performance and excessive system support. Second of all, ease of access and speed of retrieval of raw and aggregate data greatly decreases as data volumes increase. Third of all, many users are building their own time consuming and costly data collection, management, and analysis systems while proven commercial off the shelf software exists that can connect to and manage continuous data from hundreds of different automation, process control and business systems. Lastly, without the proper system interfaces and technology, integrating operational time series data and relational business data into useful information becomes a roadblock to addressing operational business issues.

Figure 1: Real-time Operations Data Management System integrating automation and business systems data.
The findings and results of both technical and business successes are examined. For the technical aspects, the results from two water utilities, Metro Vancouver in Canada and Las Vegas Valley Water District (LVVWD) from the USA are discussed. In addition to these two utilities, Halifax Water in Canada, and Water Corporation in Australia are included in the business success results where they use the data and information from the ODMS for energy management, faster water billing, water loss control, and utility efficiency are discussed.

Metro Vancouver and LVVWD manage over 200,000 tags or streams of real-time / historical data which is all time series information generated by their various, process control systems. Both utilities originally used a Relational Database Management System (RDBMS) to manage this data. With many instrument values being recorded every few seconds, the amount of data became overwhelming in terms of storage, analysis, management, support, and programming of their RDBMS solutions. The excessive time required to create reports (which sometimes took weeks to complete) and to access and analyze data became a roadblock to using the data for decision making as the task to just get data became a project onto itself. Most of the data was not being used to help better manage the utilities. Therefore, both utilities switched to a proven COTS ODMS time series infrastructure solution (OSIsoft’s PI System) and some before and after results are shown in Table 1.

<table>
<thead>
<tr>
<th></th>
<th>Before (RDBMS)</th>
<th>After (COTS Time Series)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Data Storage Size (Gigabytes)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Las Vegas Valley Water District</td>
<td>1000</td>
<td>15</td>
</tr>
<tr>
<td>Metro Vancouver</td>
<td>100+</td>
<td>6</td>
</tr>
<tr>
<td><strong>Daily Data Loading (minutes)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Las Vegas Valley Water District</td>
<td>150</td>
<td>15</td>
</tr>
<tr>
<td>Metro Vancouver</td>
<td>180</td>
<td>Real-time</td>
</tr>
<tr>
<td><strong>Report Query (seconds)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Las Vegas Valley Water District</td>
<td>360</td>
<td>20</td>
</tr>
<tr>
<td>Metro Vancouver</td>
<td>10,000+</td>
<td>5</td>
</tr>
</tbody>
</table>

Some reports at Metro Vancouver taking days or weeks for a programmer to create were created in minutes by operations and engineering end users who knew how to use the data to make insightful decisions to better manage the utility. Users leverage the full granularity of the raw real time data being collected and from this data, they can create analytical aggregate data such as 5 minute pump speeds or flow rates instantaneously. Additionally, the support and maintenance costs dropped by 70% after switching to the ODMS time series solution.

Leveraging their real-time operations data, Metro Vancouver saves $1.5 million / year on energy costs at their Annacis Island Wastewater Treatment facility (1050 MLD maximum capacity). This includes monitoring real-time energy consumption and costs to optimize use of digester gas to power cogeneration facilities, reducing natural gas consumption to zero, enhancing pump and motor efficiency (start / stops and pumping strategies), and reducing carbon footprint. Figure 2 displays real-time energy consumption and optimization at the Annacis Island Waste Water Treatment Plant through an easy to access web portal page.
In addition, Metro Vancouver leverages their ODMS for managing drinking water quality, storm sewer overflows, water billing, and utility operations optimization across their water and wastewater facilities. Their COTS ODMS time-series solution has enabled Metro Vancouver to prevent storm sewer and wastewater overflows and to speed up their water billing collection which means another $500,000/year in interest revenue [1].

At Las Vegas Valley Water District, easily accessible, timely and accurate real-time operational data has allowed them to make better business decisions in order to manage their entire water operations from water production and certification to energy and maintenance costs. Figure 3 shows how Las Vegas monitors real-time water production while minimizing costs and production while meeting the service demand [2].

Water Corporation in Perth, Australia, manages water across an area of 2.5 million km² and has nearly 1000 wastewater pumping stations. Through their ODMS, asset management dashboards use standardized key performance indicators to forecast and to predict maintenance required. This saves a considerable amount of money compared to scheduled planned maintenance. Parameters include real-time and historical analysis of run-time hours, power load on pumps, start/stops per hour enabling condition based and predictive maintenance on wastewater pumping stations [3].
At Halifax Water, as a result of its adoption of the IWA/AWWA framework and technology integration with their ODMS solution, Halifax Water has reduced leakage of potable water from its distribution system from an Infrastructure Leakage Index (ILI) of 9.0 to 3.0, which means direct savings of $600,000 per year (savings of ~$2 per person served) [4]. Using the ODMS, Halifax Water has created a real-time Water Loss Calculator and electronic Whiteboard that provides a dashboard for benchmark regional (district metered areas) night flows compared to actuals. This provides the necessary information in real-time to make optimal operating decisions and identify out of spec flow profiles that may mean a leak. Figure 4 shows their real-time water loss calculator.

Figure 3: Real-time water production optimization.

Figure 4: Real-time water loss calculator.
Servicing 150,000 people, Moulton Niguel Water District (MNWD) in Southern California is faced with rising energy costs while still needing to deliver safe, clean drinking water at a minimal cost. Their operations team focuses on managing energy as a business practice and takes into account real-time demand charges, pumping efficiency, and optimizing rate schedules to reduce energy costs.

By managing knowledge and investing in automation, MNWD has been able to reduce energy consumption, however, leveraging their ODMS with a real-time, live energy management report, MNWD has been able to further reduce pumping energy costs by 15% for their water distribution network. This translates to a savings of ~$400,000 per year [5]. Figure 5 shows the Real-time Energy Management Report that displays dynamic current, projected, and historical demand and costs plus pump efficiencies.

MNWD is further leveraging the PI System for dynamic, real-time energy management by putting some of their largest pumping stations onto demand response programs where their electrical service can be interrupted (day before notice lead time) which forces them to shift demand during critical peak pricing or pay 30+ times the regular cost for power.

### Figure 5: Real-time energy management decision report.

### CONCLUSION

Having reliable and easily accessible data is imperative in making informed decisions to better operate water utilities and manage the water lifecycle. Using a commercial off-the-shelf time series database ODMS infrastructure to collect, manage, analyze, and present operational time series data is generally superior to relational database technologies. However, the most effective ODMS solutions recognize the need for relational data and database management in conjunction with time series technologies. Without easy access to operations data, it is difficult to measure performance and to make improvements. It is this key use of appropriate technology that enables decision makers to leverage operations data for better energy management, water
quality, compliance reporting, and addressing other business issues when running water utilities and sustainably, managing the entire water lifecycle.

REFERENCES