RAGS TO RICHES – A DATA STORY

Richie Murray and Karl Pavlovich – Ergo Consulting Limited & Waikato District Council

ABSTRACT

In 2014 the Waikato District Council (WDC) undertook a project to upgrade their SCADA system to better improve the collection, storage and reporting of compliance data.

Over the past two decades the WDC SCADA system had been growing organically. New sites and equipment were regularly connected to a network reliant upon an analogue radio backbone, already under strain from high-traffic sites such as treatment plants, without regard for knock-on effects. This type of growth was starting to create significant instability in the system and as a result the system was crashing on a regular basis. Each time this occurred compliance data was lost. In addition to the stability issues, the database used to compile the compliance reports was very complex and retrieving data from the database was a time consuming manual process.

To improve the system WDC decided to implement a district wide SCADA system upgrade. The reliance upon the analogue radio system was reduced by moving the major treatment plants off the radio network and onto a 2Mb Spark OneOffice connection. This reduced radio traffic and improving the communication reliability to the remaining sites. At the same time, a new instance of Wonderware's latest SCADA system ArchestrA was developed and rolled out at both the Councils head office in Ngaruawahia and at each of the seven major treatment plants around the district. This allowed the Council compliance data to be stored in a central database in Ngaruawahia with a common tagging convention. Council also commissioned Water Outlook to provide a user friendly frontend to assist with compliance reporting. To ensure no data was lost, each of the plants was configured with default store / forward functionality enabled. This allows them to store data locally should the OneOffice connection be temporarily unavailable.

Improvements to the SCADA network and implementation of the latest industry software standards has finally placed WDC in a position to audit compliance on a minute to minute, hour to hour, day to day basis and has significantly increased the visibility of critical assets on the network. The upgrades to the system have provided significant improvements in system stability, eliminating missing data and significantly improving the Councils compliance. Looking to the future, WDC is still constantly reviewing ways to improve their SCADA system. The structure of a SCADA system is made up of many layers e.g. SCADA software, radio networks, PLC code, physical wiring, etc. and it takes all these layers working together to produce a successful system. At present Council is working on improving commutation to remote sites including a number of minor treatment plants that are still operating on radio while also building redundancy of communication to critical sites around the district.

KEYWORDS

SCADA, telemetry, radio, RTU, PLC

Compliance data

Council

1 INTRODUCTION

Telemetry, SCADA, and the Human Machine Interface (HMI) working in unison is critical to effective operation of any water and wastewater network. With two proprietary SCADA systems and 120 sites on a 300 bits per second (bps) radio backbone, the Waikato District Council (Council) SCADA system was struggling under its own weight. Issues with meeting compliance requirements in 2013 pushed the evaluation of the SCADA system beyond tipping point, something had to change. In response, Council produced a SCADA strategy document and engaged ERGO Consulting Ltd (Ergo) to deliver on this strategy. Through the implementation of this strategy, Waikato District Council had been able to deliver to Operations staff tangible improvements to how they interact with the SCADA system, as well as, develop a modernized platform set for future development.

2 PROBLEM SYSTEM

In the late 1980s the Waikato District Council (Council) was created following the amalgamation of all the local Waikato County Councils and Boroughs. This new Council then proceeded to install its first telemetry system to start monitoring its collection of remote sites. The system was comprised of Datran QRTUs and SCADA PCs located at each of the Council major population centres (i.e. Ngaruawahia, Huntly, Raglan, etc.) and was, at the time, considered a cutting-edge system.

It is from this point that the Council telemetry system was allowed to grow. The growth, over the following three decades, could best be described as “organic”, new sites were added ad hoc: pump stations, wastewater treatment plants, reservoirs and water treatment plants. Often these additions were made with little consideration to the net effect upon the system as a whole. This resulted in the radio channels becoming overloaded, but more importantly the SCADA HMI software Intouch was becoming incredibly unstable. Programming decisions made early in its development meant redundant sites could not be removed which caused database errors.

The Council system was further complicated in 2010 with the creation of the Auckland super city. During this process the Franklin District Councils water assets were split in half and divided between Watercare and Council. The Franklin district already had a well-established telemetry system which utilised the Abbey Systems RTUs. To ensure continued monitoring of all the Franklin sites, the existing Franklin system was duplicated and installed at Ngaruawahia. The net result of this approach meant the Council now had two completely independent SCADA systems each with their own HMI, historian and alarm systems.

Due to the issues being experienced on the Council’s main Intouch/Datran system there was reluctance to merge these systems at the time and as a result they continued to operate independently.

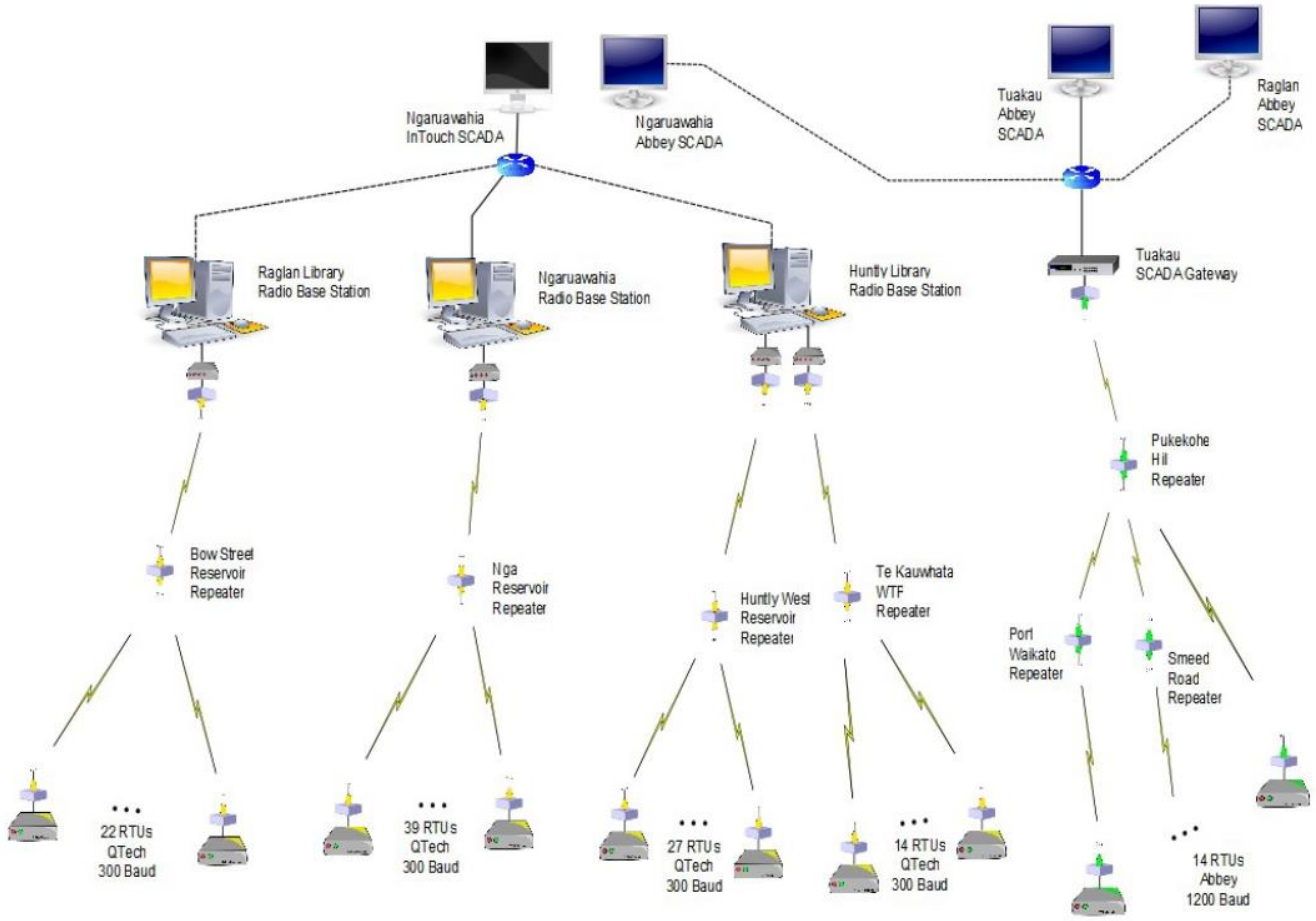

Figure 1: Network Architecture sketch 2011

By 2011 the Council system was comprised of three independent Datran/Intouch systems at Ngaruawahia, Huntly, Raglan and a fourth independent Abbey system (Fig 1). The system was identified as overloaded, susceptible to significant instability, and was not meeting the Council's operational needs. Small improvements were made to increase the overloaded radio channel speed from 300bps to 1200bps and merge all the three Datran/Intouch system into one systems located at Ngaruawahia.

However, following compliance incidents in 2013, further deficiencies were discovered in the system. This included: no traceability for receipt or acknowledgement of alarms; unable to provide change logging and as a result the accountability of Operational staff to agree upon set points was minimal; loss of communication with remote sites was not conveyed by watchdog alarms but by manually toggled polling buttons; the SCADA software was unable to support more than one remote session, leading to "mouse wars" between competing operators.

All these factors impacted significantly upon Council's ability to draw upon the system to meet compliance measures as well as presenting an impediment to the utilisation of SCADA at an operational level.

3 NEW SYSTEM

Guided by the 2013 SCADA strategy and Councils control system experts, ERGO, Council undertook a district wide SCADA upgrade. The aims of this upgrade were simple: Improve connectivity, stability, visibility, data collection, data storage, and merge the Datran and Abbey systems. It was determined that the greatest gains were to be made by replacing the overriding SCADA software with a common platform and take steps to further reduce the overloaded radio network.

To address the radio system, the project team undertook a review of the sites currently operating on the radio network. It was determined that a good starting point was to remove the data heavy large treatment plants from the radio network and place them directly onto the Council's OneOffice network.

Most of the large treatment plants already had a OneOffice connection to them with the exception of Raglan WTP, Ngaruawahia WWTP and Te Kauwhata WWTP. For these sites new connections were organised with Spark with the exception of Raglan WTP. Due to its remote location a direct connection was not possible, so a point to point link was installed between the treatment plant and the Council's Raglan Office where a OneOffice connection already existed. This action reduced radio traffic by 30% and delivered tangible improvements by reducing the response times from the remaining remote sites.

To improve the radio network further, an investigation was undertaking by the Council's telemetry maintenance contractor to review each site's radio usage. It was discovered that some sites were communication unnecessary change of state data and therefore overusing the radio network. Following these changes it was possible to get the radio usage below the 30% utilisation as recommended by the supplier, further improving system response and minimizing the number of false watchdog alarms coming through to operators. However, the radio system is still based on 1200bps analogue equipment and as a result does still pose a risk for the Council going forward.

The SCADA upgrade began with the selection of Wonderware's Archestra SCADA system at the top layer. Archestra was selected due to its object based structure. The benefits of the object structure are two-fold: 1) standardization of site presentation on the SCADA system and 2) updates could be applied across the system easily. For the Operations team this meant a consistent and reliable presentation through a fit for purpose HMI and confidence that the agreed upon HMI format could be maintained into the future.

The implementation of Archestra as per the supplier's recommendation included the use of four machines, each responsible for a part of the system. Instead of deploying physical machines, it was decided to modernise the system and use the Council's virtual environment (Fig 2).

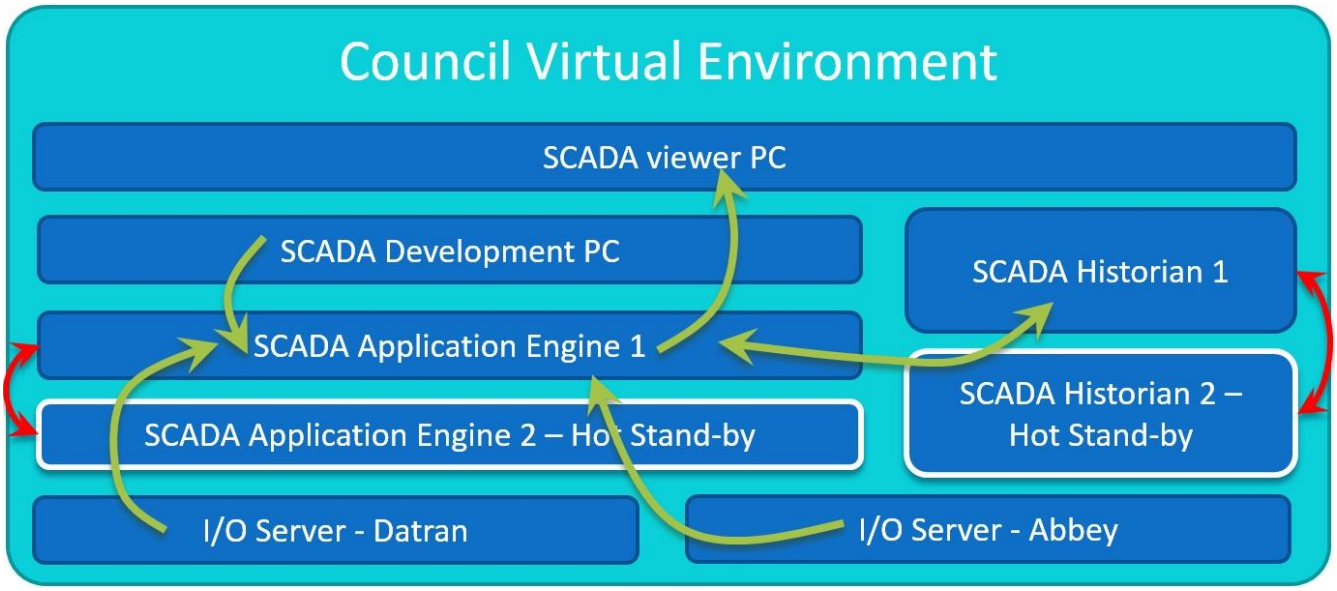

Figure 2: SCADA machine communication layout

Due to the flexibility of this environment, it was decided to also virtualise the Datran and Abbey servers and to create additional hot standby for both the application engine and historian. This resulted in a total of eight virtual machines being used to create a modern and robust SCADA system.

In addition to the benefits of virtualisation, (i.e. increased uptime, improved server provisioning) the introduction of the hot-standbys greatly increased the Council's redundancy. Also as part of the Council's IT virtual environment, all the virtual machines are backed up on a regular basis to better increase data security.

Once the new server structure was established, Archestra was then rolled out at each of the major treatment plants. Though the major plants were all connected directly back to the central system in Ngaruawahia, the sites remained autonomous with the ability to run directly from the onsite Archestra instance should connectivity to the central system be lost. In the event of disconnection from the central server, store and forward functionality built into the remote machines ensures that data is not lost and once connection has been re-established, the remote machines and central system remain live clones of each other.

These design features protected the Operations teams ability to operate the plants effectively and ensured security of compliance data.

Once all the data collected was arriving at a centralised point, the Ngaruawahia Office Archestra Server, a common historian was implemented as well as a common alarm database and distribution system (Eyeknow).

This provided Council one source of "truth" when it comes to its dataset and allowed for the application of the alarm logic to that single dataset. To protect this data, a standby historian clone was also implemented.

Through the implementation of Eyeknow, Council was also able to rationalise the nature of alarms sent through to Operations. A significant reduction in the number of alarms that existed in the SCADA system meant that only critical alarms were being attended to by Operations staff.

With the data centralised and organised with the aid of a new common tagging convention, Council was now able to easily review operational and compliance data. Data was also now able to be forwarded on to Council's data partner WaterOutlook, allowing for the easy measurement of compliance with resource consent and drinking water standards.

4 FUTURE IMPROVEMENT

SCADA systems are extremely complex systems consisting of multiple layers and it takes all these layers working together for the system to be successful. To help visualise this, ERGO has been promoting a more layered description of all the components which make up a SCADA system.

1. Layer 1 - SCADA Software Layer
2. Layer 2 - Network Backbone Layer
3. Layer 3 - Radio Network Layer
4. Layer 4 - Site Controller Layer
5. Layer 5 - Physical Wiring Layer
6. Layer 6 - Operator Procedures Layer
7. Layer 7 - Documentation Layer

To safeguard the gains and improvements realised though the Waikato District Council SCADA upgrade, Council has programmed continuous future improvements. Council have undertaken significant upgrades to layers 1 & 2. However, the other layers also require attention. These improvements will be implemented over the next few years.

5 CONCLUSIONS

After years of "organic growth", Council's SCADA system was unable to provide the necessary functionality to a rapidly growing district and was no longer fit for purpose. Guided by the 2013 SCADA strategy and Councils control system experts, ERGO, a number of upgrades and improvements have been made to Council's SCADA system. Improvements included: the deployment of Archestra; unifying multiple legacy systems; store and forward functionality and historian backup; providing data security for compliance needs; rationalisation of alarms, ensuring that Operations teams only respond to and can focus on critical alarms; transfer of data rich treatment plants from the radio network and onto the OneOffice network; improving connectivity and responsiveness to both larger plants and smaller remote sites. Through Council's commitment to continuous investment and improvement of its SCADA system, the progress made though this project will be safeguarded into the future.