INTEGRATING A REGIONS CONTROL SYSTEMS – THE STORY SO FAR.

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ABSTRACT

Wellington Water (Formally Capacity Infrastructure Services / Greater Wellington Regional Council (GWRC) Bulk Water) provides water, wastewater and stormwater management services to clients throughout the Wellington region which include Greater Wellington Regional Council (GWRC), Hutt City Council (HCC), Porirua City Council (PCC), Upper Hutt City Council (UHCC) and Wellington City Council (WCC).

This paper documents the transformation and convergence of the electronic control systems, which manage the bulk of the assets since 2012 until 2015. It also provides some incite of the roadmap going forward for merging with the GWRC Bulk Water systems. It highlights the benefits of moving to a regional approach in being able to do more with the resources (Staff), shows how Standardisation in different areas of work build upon each other to provide a more efficient system providing easier access to regional, solid data for the decisions of the future.

KEYWORDS

Control systems, SCADA, Telemetry, Regionalisation, Resilience, Standardisation, Digital Microwave Radio (DMR)

1 INTRODUCTION

This paper focuses of the control systems of the four city's for which Wellington Water manages the water services. These four cities originally utilised seven separate systems for the monitoring of over 350 sites.

2 AN OUTLINE OF THE SYSTEMS IN 2012

2.1 TYPES OF ASSETS MONITORED

- Water reservoirs
- Water, Wastewater and Stormwater pump stations
- Water pressure reducing valves
- Water metering including flow and pressure monitoring
- Wastewater flow monitoring
- Rainfall volume
- Site security
- Dams
- Bore pump stations
- Storm water culvert levels
- Penstock control

2.2 THE 7 SYSTEMS IN 2012

2.2.1 HCC (QTECH DATA SYSTEMS) UHF / CELLULAR TELEMETRY

One Primary Telemetry Engine (Telcon) located at the Capacity offices on the Petone esplanade providing the day to day monitoring and control of 101 telemetry sites, which are monitored by Qtech RTUs connected to local PLCs and instrumentation. These sites used four UHF repeaters and the public cellular network to communicate back to the Primary Telemetry Engine.
One secondary Telemetry Engine (Telcon eavesdrop) located at Pavilion, a purpose built Emergency Management office used for the Hutt Valley. This secondary Telemetry Engine had a dual function and is also the secondary telemetry Engine for the HCC Bulk Water sites.
The HCC system used Wonderware's Intouch HMI to graphically represent the telemetry data sourced from the Telcon Telemetry Engine using the Dynamic Data Exchange protocol (DDE).
The Historical data for the Hutt City was stored in a Qtech SQL time series Database.

2.2.2 HCC BULK WATER (QTECH DATA SYSTEMS) UHF TELEMETRY SYSTEM

One Primary Telemetry Engine (Telcon) located at the Seaview WWTP, providing the day to day monitoring and control of 30 telemetry sites which are monitored by Qtech RTUs connected to local PLCs and instrumentation. These sites use three UHF repeaters to communicate back to the Primary Telemetry Engine
One secondary Telemetry Engine (Telcon eavesdrop) located at Pavilion.
The HCC Bulk Wastewater system uses Wonderware's Intouch HMI to graphically represent the telemetry data sourced from the Telcon Telemetry Engine using the Dynamic Data Exchange protocol (DDE)
The Historical data for the Hutt City Bulk Wastewater was stored in a Qtech SQL time series Database

2.2.3 PCC (ABBEY SYSTEMS) RADIO TELEMETRY SYSTEM

One Primary Telemetry Engine (Powerlink Master) located at the Porirua City Council offices, providing the day to day monitoring and control of 62 telemetry sites which are monitored by Abbey Systems RTUs connected to local PLCs and instrumentation. These sites used two UHF repeaters and one VHF repeater to communicate back to the Primary Telemetry Engine and the secondary Telemetry Engine.
One secondary Telemetry Engine (Powerlink Backup) located at the Porirua City Council offices.
One Disaster fallback Telemetry Engine (Powerlink Disaster Master) located at the Porirua Works Depot
The Porirua system used Abbey Systems ASPEX HMI to graphically represent the telemetry data sourced from the Powerlink Engine using a proprietary protocol.
The Historical data for the Porirua system was stored in an Abbey Systems bespoke storage format and pushed to a SQL database managed by PCC IT.

2.2.4 PCC (CHELLO) CELLULAR LOGGERS

One Cellular logger controller (Pmac) located at the Porirua City Council offices.

2.2.5 UHCC (ABBEY SYSTEMS) UHF TELEMETRY SYSTEM

One Primary Telemetry Engine (Powerlink Master) located at the Upper Hutt City Council offices providing the day to day monitoring and control of 47 telemetry sites, which are monitored by Abbey systems RTUs connected to local PLCs and instrumentation. These sites used one UHF repeater and one VHF repeater to communicate back to the Primary Telemetry Engine.
The Upper Hutt system used Abbey Systems ASPEX HMI to graphically represent the telemetry data sourced from the Powerlink Engine using a proprietary protocol.
The Historical data for the Upper Hutt system was stored in an Abbey Systems bespoke storage format.

2.2.6 UHCC (CHELLO) CELLULAR LOGGERS

One Cellular logger controller (Pmac) located at the Capacity office.

2.2.7 WCC (ABBEY SYSTEMS) RADIO & CELLULAR TELEMETRY

One Primary Telemetry Engine (Powerlink Master) located at the Capacity office providing the day to day monitoring and control of 201 telemetry sites which are monitored by Abbey systems RTUs connected to local PLCs and instrumentation. These sites used Seven UHF repeaters, one VHF repeater and the public cellular network to communicate back to the Primary Telemetry Engine and Secondary Telemetry Engine (Powerlink Backup) located at the Capacity office.
The Wellington system was also linked to the GWRC Bulk water telemetry system using UHF and serial at multiple levels because of the history of the region when GWRC maintained the Wellington City Water Telemetry.
The Wellington system was also linked with the Porirua system using 4-20mA
The Wellington system used Abbey Systems Powerlink, ASPEX HMI and Intouch to graphically represent the telemetry data sourced from the Powerlink Engine using OPC.
Wellington City also used the Wonderware Historian software to store its historical data.

2.3 THE MAIN ISSUES

2.3.1 DUPLICATE RTUS AT SITES

In conjunction with the above telemetry systems GWRC Bulk water operated another Abbey Systems Telemetry system, which requires duplicated RTUs at the key water supply reservoirs; often a site would have two Remote Telemetry Units (RTUs) at a site monitoring the same information. E.g. a reservoir monitoring Level, flow inflow and outflow for both GWRC Bulk Water and WCC. These RTUs would then both communicate via the same radio repeater but back to different Telemetry Engines. These Telemetry Engines then re-shared the information with each other via a serial link.

2.3.2 INCREASED NEED FOR SHARING DATA BETWEEN SYSTEMS

As with the GWRC Bulk Water and Wellington Serial link, the other councils also had more requirements for sharing data with each other. Sharing serially in the same way the above link between GWRC Bulk Water was not recommended by the manufacturer due to the added complexity. The need for the interlinking is for verification of flows between the cities. i.e. UHCC Waste flows to HCC, WCC Waste flows to PCC & GWRC bulk water flows to the four cities.

2.3.3 INCONSISTENT HISTORICAL DATA STORAGE DATABASES

HCC was using the Qtech Data Systems SQL Historian.
PCC was using Abbey Systems bespoke Event file storage & pushing to a PCC IT managed SQL database.
PCCs Chello loggers were storing to their own data file formats on a PCC dedicated Chello Controller PC.
UHCC was using Abbey Systems bespoke Event file storage & pushing some information to the WCC Wonderware historian.
UHCCs Chello loggers were storing to their own data file formats on a UHCC dedicated Chello Controller PC.
WCC was using Abbey Systems bespoke Event file storage & pushing some information to the WCC Wonderware historian.

2.3.4 NEW SITE INSTALLATIONS HAD NO STANDARD DESIGN CONTROL ALGORITHM

Many sites were due for upgrade in the upcoming CAPEX programme and although it could be seen that there had been some standardisation over the years, often site electrical designs and site control philosophies had been developed by separate parties with differing scope requirements, e.g. a waste water pump station build by a developer and only handed to council after the suburb became fully developed. As such, the operations team which take over the WWPs or the Asset Development department may not have had input onto the design to ensure that it would integrate nicely.

2.3.5 RADIO COMMS CHANNELS AT OR NEARING SATURATION

Historically the telemetry systems were added after the bulk of the assets were built. As such the design of the radio infrastructure was designed for the sites which needed telemetry adding. With new sites being in filled such as booster pump stations, area water meters, PRVs or storm water pump stations. This caused the utilisation of the unused bandwidth to increase to a point at which adding a site, increasing the polling to a site or increasing the amount of data required from a site could have serious impacts on the communications to other sites using the same repeater.

The sharing of repeaters between GWRC Bulk Water and WCC only extrapolated this, being separate entities at that time the developments of their systems were separate and therefore a planned change on one system could impact the others communications reliability.

3 ELECTRICAL AND CONTROL DESIGN STANDARDISATION

3.1 SITE ELECTRICAL DESIGN STANDARDISATION

Many of the waste water pump station and water pump station control panels in Wellington city were coming up for renewal and the waste water pump station panels had originally benefited from rigid standardisation, which is why they were able to be supported and maintained for so long. With new products on the market and the installed ones coming to the end of their life, it was decided that some strict standards would need to be developed. Working with BTO we developed a new standard electrical design which mimicked the original in some way. Our thought was that there was no need to completely redesign the wheel when the approach previously taken had worked so well and for so long. The operators and their safety was considered significantly during this design so as to minimize issues with users getting to know the new electrical panels and trying to work out some of the issues they had with the old design.

Joule Products Ltd fabricated the first few panels and we worked with them and the installation contractor Proserve Ltd to tweak the design a little further.

What we ended up with is some modular designs for both above and below ground waste water pump stations plus Water pump station panel which could easily be expanded from 2 -> 3 -> 4 pump variants.

Because of the background of our operations team, being electricians and electrical engineers and having extensive experience with the new telemetry units being installed in the panel, the electrical design was able to be tailored to the strengths of the RTUs.

3.2 ELECTRONIC CONTROL STANDARDISATION

Alongside the electrical designs for the WWPS and WPS sites we began to work closely with Abbey Systems on the creation of some standardised configuration templates and site control philosophy. Being operations personnel primarily but also responsible for the electrical control equipment and instrumentation at site together with the control philosophy meant that we had a strong understanding of what was working in the field and what wasn't. As with the electrical designs we continued to tweak the design over the 1st year as we only installed three water pump stations and two waste water pump stations during the first year.

The standard configuration templates we developed along with control philosophy was able to be easily configured with almost "tick-box" like configuration options for selecting the number of pumps required at a site.

4 EVALUATION OF HMI SOLUTIONS AND HISTORICAL DATA STORAGE OPTIONS & QUICK WINS

4.1 EVALUATION HMI SOLUTIONS

4.1.1 PMAC

With PCC and UHCC using Pmac to graphically represent the locations of the Chello loggers this system was briefly reviewed. As its primary function was to display the trends of the cellular loggers and not to present a "live" representation, it was quickly discounted to be used as the primary HMI for all systems. The Pmac system does however have a valuable use as part of the wider data collection whereby we can use Pmac as a telemetry engine to concentrate the collection of Chello logger information and then integrate the data into the greater system.

4.1.2 ASPEX

With PCC, UHCC and WCC using ASPEX in various states of development, Aspex was considered a possible candidate for the Primary HMI.

WCC had many sites partially configured but occasionally as upgrades had occurred the ASPEX had not been updated to reflect the changes. Field operators did not regularly use the ASPEX software and this is likely one of the reasons that the configuration had become mismatched.

UHCC had all of its sites configured, but the graphical representations were dated and the latest functions such as datalogged trending were not being employed. Field operators regularly used the graphics and so although the screens didn't look flash, there were very functional.

PCC had all of its sites configured using the latest styled graphics and functions. In addition to this PCC was using Abbey Systems Secure-link product, which enabled operators to run the ASPEX HMI on their laptops in the field and review the site information when they wanted too. This was comparably different to the other cities that all relied on dialing into a central system and sharing a remote computer.

4.1.3 WONDERWARE INTOUCH

HCC, HCC Bulk Water, WCC, Moa Point WWTP and Western WWTP all used Intouch in various states of development; Intouch was considered a possible candidate for the Primary HMI.

Consideration was given to the fact that GWRC Bulk Water used Citect and that Porirua WWTP and Seaview WWTP used RSView, however, with the significant development which had been undertaken in creating the HCC, Moa Point WWTP and Western WWTP plus the number of licenses and the total value of the software, coupled with the fact it was communication with different platforms already PLCs in the WWTPS, Qtech in HCC and Abbey Systems in WCC.

Wonderware's InTouch became the clear favorite for a regional HMI.

4.2 WONDERWARE SYSTEM PLATFORM WITH ARCHESTRA IDE

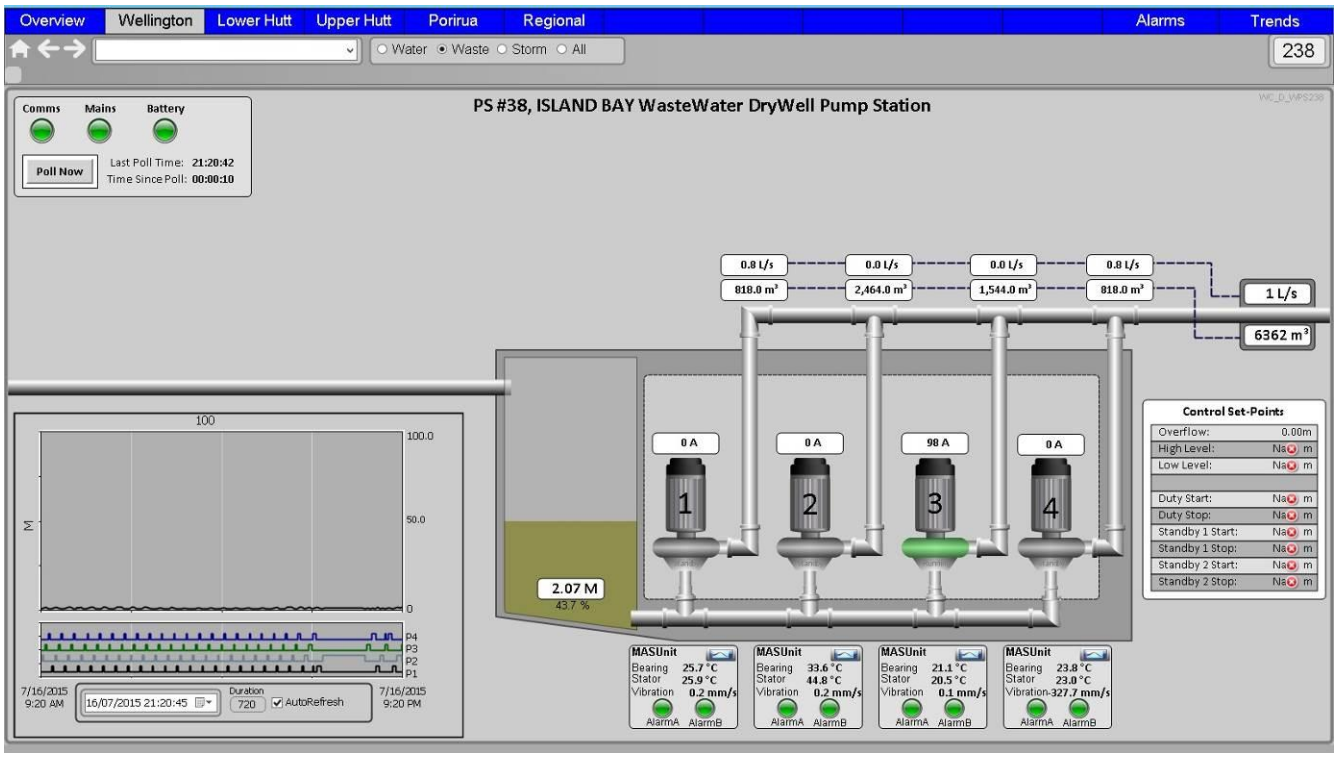
If classic Intouch was clear favorite, then why have we ended up using System platform with Archestra IDE?

The Archestra Integrated Development Environment (IDE) allowed us to manage both Intouch graphics projects used by HCC and WCC in a more controlled way. It allowed us to manage where the graphics were deployed to e.g. to different physical locations such as the Capacity office or our primary maintenance contractors office in Seaview. It allowed us update screens and manage their deployment from a central repository. In order to create any kind of standards, control of who can do what is a must.

It also allowed us to begin development on a third regional graphics project while still supporting the historical ones during the development. This was probably the most important improvement, because being able to test out the new standards without adversely impacting on the operational functionality for the users was a huge benefit, which allowed some trial and error to occur in a non-production environment, previously there had not been anywhere to test things other than on the live (user facing) system.

The Archestra IDE also presented the option of using modern vector graphics so that the new HMI screens could look flash if we so wanted. In creating this new regional graphics we have used some newer more stylized graphics but were trying to develop the system using situational awareness techniques.

Figure 1: Island Bay HMI screen

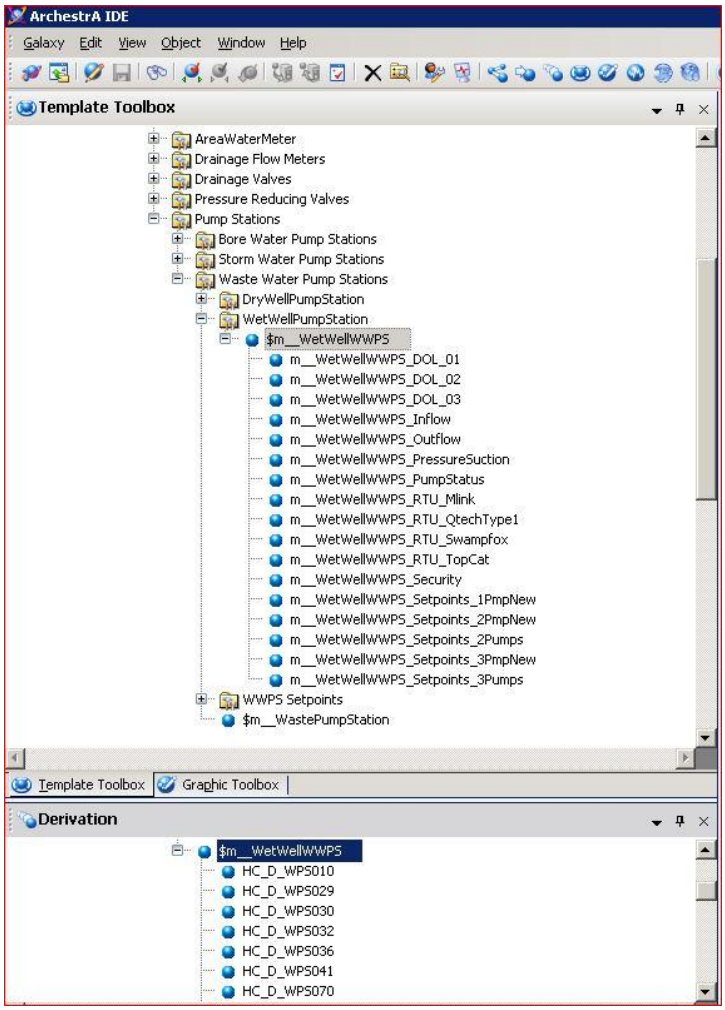


Above is a screenshot showing the current stage in development of our WWPS screens. The look is intentionally grey or non-descript, any red or flashing is strictly reserved for errors or problems. The intention is that the red fault icons on the right of the image together with the green pump 3 running indication are what draws the eyes. Perhaps we don't have it quite right just yet and the other green indications for comms etc. need to be made smaller or changed so that they draw less attention. If the situation is normal, then we do not really want to attract the operator's attention to tell them situation normal.

System Platform is the next step in evolution relating to HMI development for Wonderware. It still uses Intouch as the "pin board" for mounting graphics, but it also allows the creation of templates which can then have new instances created based upon those templates and rolled out again and again with an extremely short configuration time.

From figure 2 to the right you can see how the templates are created. $m__WetWellWWPS is a template for wet well pump stations. A new instance can be created based upon this template and the equipment which is not needed can simply be deleted. Take for example the RTU section. Each site does not have four RTUs. Instead the ones which aren't required are deleted.

Figure 2: Archestra screenshot



Also at the bottom of the image you can see the pump station configurations which have been derived from this template.

The same applies for all other types of sites. We create a template with all the possible combinations of equipment that might be installed then just delete what is not needed.

If a new device is required at a site e.g. a delivery pressure transducer. It is created in the IDE and simply added to the template. Then a new instance of the template delivery pressure object is created.

This will ensures consistency going forward regardless of which individual is carrying out the work.

Another feature which is envisioned will assist in the speed of development of the HMI is that objects or graphics are "check out" when a user opens them for editing. This means that multiple engineers can carry out either development of the objects graphics or configuration of new sites at the same time. This "checking out" or version control together with maintaining records of which instances are developed from a particular template means that if an instance's template is updated, the instance will know that it needs to receive the update and the system administrator can then manage the roll out of the updates.

For example: a reservoir object has level in percent. If the reservoir template is updated to include a calculation which derives the volume from the level, then this update can be deployed to all appropriate reservoir instances. Only the individual reservoirs volume at 100% needs to be inputted into the individual instance assuming the calculation is correct for the level to volume relationship.

4.3 EVALUATION HISTORICAL DATA STORAGE OPTIONS

4.3.1 POWERLINK EVENT STORAGE

With PCC, UHCC and WCC all using Powerlink event storage, a good commonality already existed which could have proved promising, however because this system is bespoke to Abbey systems it was decided that there was little point in looking to develop it to include another Telemetry manufacturers data.

As such using Powerlink Event storage regionally was ruled out.

4.3.2 QTECH SQL HISTORIAN

The fact that Qtech was using an SQL database was useful as third party reporting software could be used to extract data from the database, however again it was considered too problematic to look to develop it to include another Telemetry manufacturers data.

As such using Qtechs SQL historian storage regionally was ruled out.

4.3.3 STANDARD SQL DATABASE

Porirua was also using a standalone SQL database and the fact that this meant that both Abbey Systems and Qtech could be pushed to the same database was promising, however the Wonderware Historian solution just showed so much promise that using a standalone SQL database as a historian regionally was ruled out.

4.3.4 WONDERWARE HISTORIAN

Wellington was already using the Wonderware historian to a significant degree. In early 2011, UHCC had been configured to push many of its key values to Wellington's Historian. This allowed the Engineers to more easily review what had happened in both Wellington and Upper Hutt from one system.

The Wonderware historian also has a few client applications, which allow the review of the historical data in different ways e.g. via trends or via an excel plugin. The excel plugin was already being used daily to review the water consumption for Wellington.

The Wonderware Historian also offered direct integration with Wonderware System Platform which meant that when the new sites were being created for the HMI, a simple tickbox option could be selected to historise the data.

It was determined that the simplest and most time and cost efficient approach was to use the Wonderware Historian.

4.4 QUICK WINS

The added benefit was that because the Hutt system was already using Wonderware Intouch product there could be easier integration with the Wonderware Historian database. The IT and protocol issues were worked through and within about a week we had imported all of the datapoints being displayed on the Hutt City Intouch into the Wonderware Historian so that they could be reviewed using the Engineering client software tools.

Although a massive leap in integration and improvement for the end users of the historical data, because the datapoints (and their naming) had been developed at different times by different people in different councils it meant that no councils data points were named in a convention way.

4.5 TAG STRUCTURE

We discussed this issue and also reviewed the option of moving to a common HMI with the Wonderware NZ representative Process Software Ltd. They suggested a local contractor to partner with to assist in developing our plans for integration. We built a relationship with the local contractor Control Box Wellington Ltd and over 12 months developed a standard datapoint or "Tag" naming convention which was uniform and allowed for all foreseeable datapoints. At this time Porirua had not joined Capacity Infrastructure Services but within the new naming convention tag structure we allowed for it.

Now we had finalised our tag structure we needed to review the best way to create new tags for all the datapoints, so that it would be consistent and easy to use. At that time Wonderware had recently started rolling out its new product Archestra system platform which was designed for a “cookie cutter” approach to Tag creation and graphics development.

We decided to merge the Wellington and Hutt City Wonderware systems into one system so that we were able to leverage the benefits of being one large customer, which provided a larger discount when upgrading to the Archestra system platform software. At the same time we procured a HMI license for UHCC so that all three councils had HMI terminals.

The next 12 months we spent developing the cookie cutters for the tags which together with our field standardisation meant that once the cookie cutters were complete we could create 20 plus full sites plus per day (Historical data collection only) we still needed to develop the site HMI cookie cutter.

We are still developing some of the HMI cookie cutters (July 2015) but once complete, the graphics will be able to be rolled out in a matter of days rather than weeks. New sites can now be configured end to end in a few hours including RTU program deployment, Data Tag creation, historian data storage and graphics deployment.

5 REGIONAL COMMUNICATIONS INFRASTRUCTURE ISSUES AND RESOLUTIONS

5.1 GOOD ENGINEERING BEFORE GOOD POLITICS

Because the WCC and GWRC Bulk water shared UHF repeaters this could cause issues as WCC rolled out new sites for Area Water Monitoring and GWRC Bulk water increased the frequency at which they needed to poll their sites or increased the amount and frequency of datalog uploads from the RTU.

The issue was becoming clear. Everyone wanted more data from more sites more often. As the systems used UHF and VHF with relatively slow speeds of data transfer 9,600 Bits per second, the loading of these more & more & more demands was causing the radio network to become saturated. The simple option would have been to add another repeater channel, but this would only delay the problem and so it was decided to review the whole communications infrastructure.

Capacity Infrastructure Services formed a working group with our control systems counter parts in GWRC Bulk water and decided to put good engineering ahead of the politics of being two separate entities. We could see that the logical approach was for us to work more closely together rather than defend our patches.

5.2 DETERMINING THE MOST APROPIATE SOLUTION

A core Idea which sprouted was that rather than focus on where the System Engines and servers were located, instead we should focus on the network and ensure that it would be as resilient as possible.

The ever present thought of the Wellington big earthquake and the recent earthquakes in Christchurch helped drive this direction.

Because of the distances we needed to cover and the cost and time in finding and rectifying faults in cables we directed our solution to be a radio based one. We have the radio skills in house and have some contractors with radio skills also, our focus being that after “the big one” we could look to fix the communications ourselves or request contractors do so, and because its point to point radio, it limits the potential sites that faults can occur.

Our approach was that if we created a communications backbone which was resilient then we could just redeploy our telemetry engines and servers to another location if required. The easiest resilient network is a ring whereby each site has two connections, as such if one fails the other can be used to transmit the data. Our project requirement became ~~one ring to rule them all~~ to create a resilient network where each repeater site had at least one alternate path.

We attended the Radio User Frequency Association New Zealand (RUFANZ) conference and gained an understanding of the UHV/VHF / Wi-Fi / DMR players for radio network infrastructure and moved on to selective tender with the hope of developing a relationship for the project. The successful winner of the Tender was Aviat Networks who proposed a Digital Microwave Radio solution.

Photograph 1 to the right shows that you can’t beat wellington on a good day and also shows two microwave links on top of a reservoir which is also used as UHF repeater site. The UHF repeater aerial can also be seen in the background

Photograph 1: Microwave dishes

5.3 THE REGIONAL PROJECT TEAM

We agreed that GWRC Bulk Water would manage the project and used their preferred contractors, Les Stuart Electrical Ltd for electrical Installations & Aqua Installations for mechanical installation work.

Using Aviat Networks for radio system design, Neos systems Ltd for IT and routing design support and configuration, Blue Cube Security Ltd on the initial scoping out of the radio paths, Cardno for project management. We had discussions with Qtech on the detailed design for the Hutt system interconnections. Abbey Systems helped with some installation and testing concept designs for interconnection of the WCC and GWRC Bulk Water systems at the sites. Kordia were employed for final link optimisation.

5.4 THE END PRODUCT – THE TELEMETRY IP NETWORK

The final design comprised of linking together all of the repeaters used by HCC, PCC, UHCC & WCC in a ring topology with currently one cross link and two spur sites.

The network is currently utilising ~0.3% of the available bandwidth and so allows for other regional services to be added such as Regional Emergency Communications or possibly other smart networks such as smart street lighting.

The biggest task going forward is likely to be the governance of the network with four city councils and one regional council having part ownership. Below is a logical representation of the network. Drawn geographically the network looks much more complicated and is harder to follow. The Aviat product used for this network does not include a layer 3 router and so Mikrotik routers were used instead to create a layer 3 routed network. Significant thought was given to future expansion and IP address allocations were used in a logical way relating to the existing SCADA as opposed to a purely IT networking approach.

Photograph 2: a sample repeater site

The Power supplies, dish mount bracketing, associated earthing together with the suitability of installation buildings was afforded an appropriate level of attention and resulted in three new building being installed. The microwave mounting pole was particularly well designed in that it could be installed on the ground, on a flat reservoir roof or on a domed reservoir roof yet was in essence a standard design made up of a center pilotable pole surrounded by three pilotable legs which can be adjusted to orient the pole vertical regardless of the base.

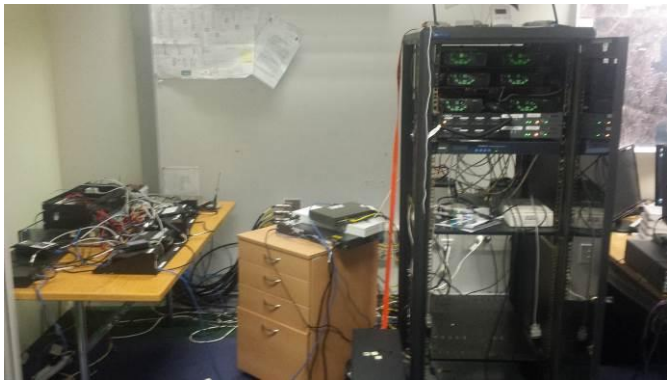
All equipment was mounted in 19" racks and had approximately three days battery backup. Photograph 3 shows a typical installation (minus routers and SCADA Gateways).

Photograph 3: A Typical Install

6 OFFICE RELOCATION

In 2014 it was decided that Capacity Infrastructure services and GWRC Bulk water would merge into Wellington Water. As part of this merger an office relocation would be needed as the Capacity office was not large enough to incorporate the extra staff. Because our Network communications design focused on the resilience using the ring approach we were able to make some small changes to the design to include decommissioning of the Capacity office and decided to relocate the City Council Telemetry engines and servers to the Waterloo WTP and Pavilion. Both of these buildings are council owned and not envisioned to be being significantly changed in the near future. Both have UPS systems installed and backup generators on site, again improving the resilience of the system as a whole.

Photograph 4: Office Relocation



As part of the relocation / Ring commissioning the Primary Engines were moved to Waterloo and the Secondary engines were relocated to Pavilion. This provides symmetry to the system and the simplicity of having things installed in a standard way at two standard locations.

Photograph 4 shows some of the equipment during the office relocation.

As you can see there are a multitude of connections and keeping the control systems operational during the relocation was very involved. It went well but that isn't to say we didn't have any issues.

7 CONCLUSIONS

Standardisation; from site designs to control philosophies to repeaters to Telemetry engine installations to tags formats and HMI graphics build upon each other to create a simple but robust system which

Operational Input; Operations staff should be afforded more time to assist with key projects because what often gets missed is something simple which cause the end users problems.

The right software for the right job; Having lots of different types of software does not necessarily make a system more complex if each piece of software can have a clear defined role and demarcation points.

Control systems and IT Convergence; what were control systems is becoming more IT related and what was formally IT is having to integrate more with Control systems. Using people who understand these two fields and their boundaries is key to implementing a successful future integrated system.

Long or Short development; a long development will result in an approach which has been fully through and will probably have more longevity. Shorter development times will likely result in more reworks being required. Sometimes it's best to take a slower approach because the assets and systems are hopefully going to be there for a long time.

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REFERENCES

Resilience in water and waste water telemetry and control systems by Lester Abbey, Abbey Systems CEO presented at Water NZ

Situational Awareness – The Next Leap in Industrial Human Machine Interface Design by John Krajewski, Product Manager HMI/SCADA, Schneider Electric