MONITORING AND CONTROL OF WATER ASSETS USING WIRELESS TELEMETRY

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ABSTRACT

Through the advancements in wireless technologies they can now today provide cost effective solutions whilst maintaining reliability, increased productivity and maintaining operator and engineering safety.

The combination of different technologies allows us to regain control and capture more data than we have ever had before. Collection and storage of real time data, historical maintenance records and preventative maintenance logs from local or vast geographical areas are key driving considerations in the use of wireless telemetry in the water industry today.

The paper will look at Cobar Shire Council water supply system which includes vast uninhabited areas, and isolated remote villages where the water supplies are critical pieces of infrastructure. The paper will look at the challenges faced and the issues that wireless systems need to overcome in local distributed systems and also vast regional and remote areas. The demand on utilities is increasing and with the use of wireless telemetry, a faster response time and a lower cost of maintenance for these networks is a key consideration in making these projects come to life.

1.0 INTRODUCTION

Water / Wastewater (W/WW) systems generally rely on wireless networks to communicate over vast distances of difficult terrain that are often heavily obstructed. Typical application examples where wireless is employed include:

- Water quality monitoring,
- Tank level monitoring,
- Early flood-warning systems,
- Pump station control,
- Valve positioning,
- Monitoring of reservoirs and dam levels,
- Surveillance of assets.

Water systems contain key infrastructure such as: reservoirs, water storage tanks, piping networks, associated pumps, and treatment plants. There are variations of equipment depending on the size of network and the availability of water; be it from river, bore, catchment dam or other.

Also the geographical area of some systems that require monitoring and control varies from town to town and can range from hundreds of meters to hundreds of kilometres. Wireless systems often require different types of radios to fit with the varying distances and the application, i.e. short distance intra plant network's do not require the use of higher power radios, whereas wider networks may require the use of radio systems with strategically placed masts & repeaters and using licenced frequencies or the use of a Cellular network backbone.

2.0 FREQUENCY SPECTRUM

The Australian Frequency Spectrum is governed by the Australian Communications and Media Authority (ACMA) which dictates as to which frequency, power limits, and modulation types can be used. In the Industrial Scientific Medicine (ISM) frequency spectrum the common frequencies used in the W/WW industry are the 150MHz & 400MHz Fixed Frequency, 900MHz Frequency Hopping Spread Spectrum (FHSS), 2.4GHz & 5.8GHz Direct Sequence Spread Spectrum (DSSS), and more recently the Cellular bands through the use of both public and private cellular connections.

Fixed frequency radios are typically licenced radio bands providing users with a set list of allowed frequencies that will not be used by any other system within the geographical area. These licenced radios also typically allow for higher RF power allowing for greater distances to be achieved and assist in areas of dense obstructions over long distances. FHSS and DSSS radios on the other hand are typically licence-free with lower RF power limits and being licence-free, the spread spectrum technology allows for the radios to either change frequency within their set parameters to avoid interference or provide a greater bandwidth for low latency systems. Radio modulation schemes continue to evolve resulting in higher throughputs, greater distance ranges, increased performance in the presence of interference and better co-existence with other nearby radio networks. We have seen this evolution change dramatically in the public arena especially in the cellular world with 2G being surpassed by 3G, and now 4G/LTE. Advances are also occurring in the popular open 802.11 standards with 802.11b being surpassed by 802.11g, and now 802.11n. The result is a wireless network that is increasingly more reliable with superior performance.

3.0 PROTOCOLS – PUBLIC OR PROPRIETARY

Many users wish to utilise public or open wireless protocols for compatibility with multiple manufacturers, for example 802.11a/b/g is a public protocol that enables say a laptop, made by company X, to communicate with a wireless router, made by company Y.

The 802.11a/b/g protocol is available using many wireless modules, however many are not designed for harsh environments or critical control and monitoring that is required in W/WW applications requiring a robust, reliable and adaptable system.

Many manufacturers of industrial wireless equipment have produced their own proprietary protocols that are optimized for a specific application. The benefits of using a proprietary protocol include: more secure data transfer, reduced overheads, allowing more throughput for actual user data and smaller data frames allowing better penetration of signal and optimised message handling for critical assets. Through the use of Internet Based (IP) protocols greater interoperability of manufacturers radios are now starting to emerge be it proprietary or public protocols for the wireless side of the network via the networking protocols such as Modbus TCP, Ethernet IP, DNP3 etc.

4.0 APPLICATION

The following application depicts a Telemetry installation for a water supply system at Cobar Shire Council which is located approximately 700Km northwest of Sydney and has an area of 44,065 square kilometres. The Telemetry system was designed and installed by Indratel which is a specialist Telemetry supplier and integrator based in Newcastle NSW. The initial system design has subsequently been expanded to include linking of the three distant remote Cobar Shire villages of Mt Hope, Nymagee and Euabalong back to the existing Cobar Shire Council network which provides monitoring and control of Pump Stations and reservoirs at all locations.

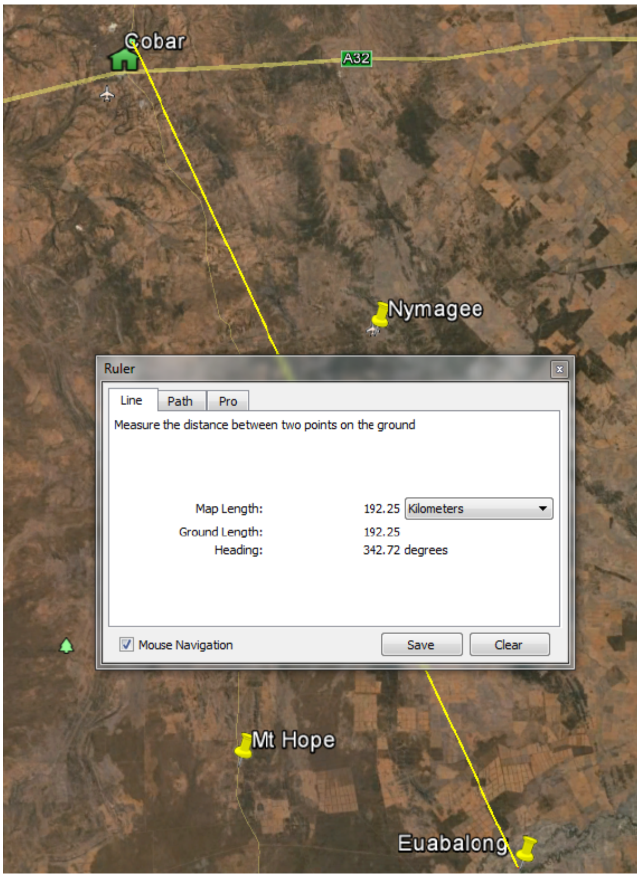

Figure 1: ***Cobar Shire Application Area***

The initial installation was installed in 2010 around the Cobar region for the Council, Water Board and Endeavour mine which is approximately 50km from Cobar. The initial system uses licenced fixed frequency I/O based radios monitoring level of reservoirs, flow meters, storage tanks and control of pumps. Many of the sites are very remote requiring the use of Solar Panels and batteries which provide power to each radio and associated equipment.

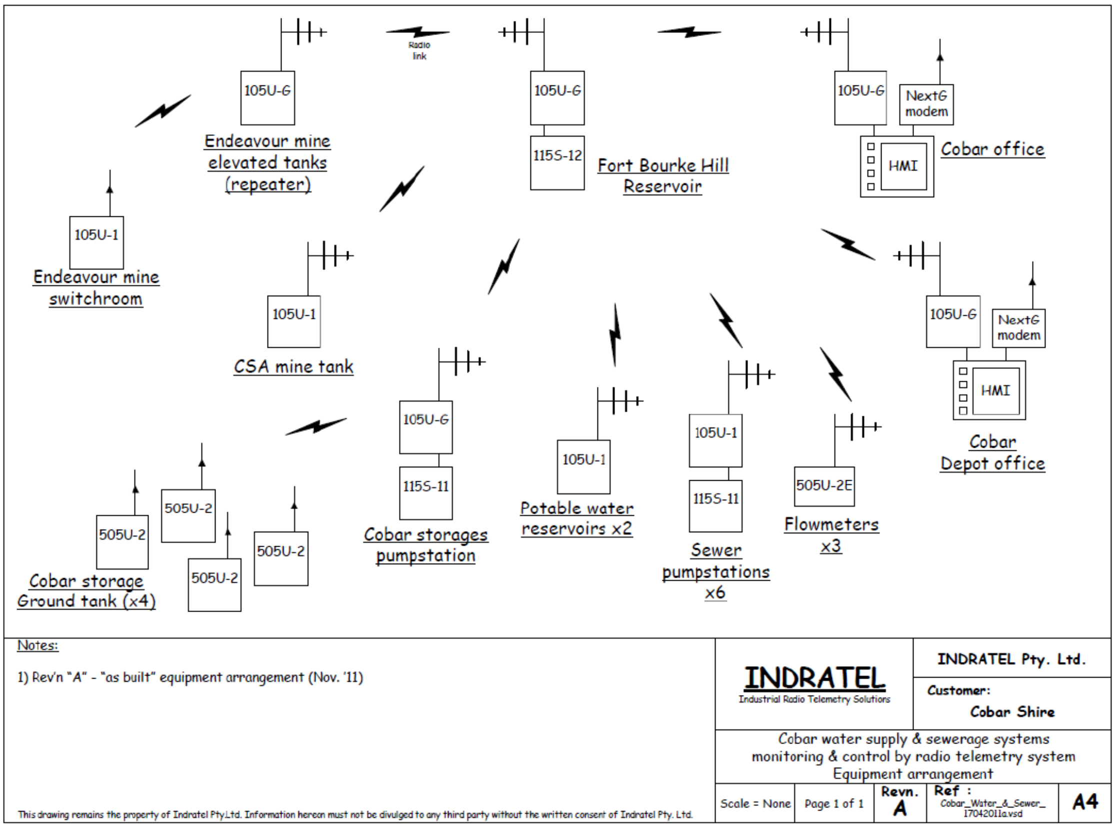

Figure 2: *Initial Cobar System*

Through 2011 to 2013 the expansion of the network in Cobar for potable water and sewage pump stations and the addition of the remote outlying villages of Nymagee, Mt Hope & Euabalong saw new challenges in providing both a remote monitoring / control and a decentralised network. With distances of up to 190km from Cobar to Euabalong and knowledge of the terrain along with access restrictions throughout the areas in providing a secure and reliable wireless network meant the use of a deploying a hybrid approach on combining different technologies to provide a secure, reliable cost effective network. This was achieved by the means of connecting the remote villages back to Cobar via a combination of IP based Wireless I/O Radios through a private 3G Cellular backhaul link. All remote villages have their own I/O based radios that can maintain local control which call for water between pump station and reservoir along with being monitored at Cobar through a HMI system. The HMI system is used as an alternative to a PC Based SCADA system as it provides SCADA type functionality in an easy to use industrial hardened device.

The HMI system has been designed and integrated by Indratel to provide a long and reliable service life which integrates all prior existing Cobar and water board radios along with newly added villages system and includes a cellular modem to allow for SMS alarming, and for remote technical support; these systems are an extremely cost effective and reliable means of monitoring, controlling, alarming and data logging for regional shire water & sewer systems.

Figure 3: ***Cobar Shire HMI & Radio Cabinet***

4.1 Wireless Backhaul

With knowledge of the Cobar Shire, villages and surrounding area Indratel saw that the best solution for Cobar Shire Council was to provide the backhaul of each village back to Cobar via the use of a Private 3G cellular link utilizing Generic Routing Encapsulated Tunnels (GRE), which create transparent pipes between each village and the Cobar Shire HMI using the Telstra 3G Network. Being a private 3G connection data is not accessible to the public domain and the configuration made only allowed connected sites to communicate with each other (preventing any external connections) and hence providing a secure network.

Indratel reviewed other options of installing fixed frequency licensed radios to provide the backhaul however the costs associated in gaining access to required sites for repeaters, costs of installation of towers and gaining access to these sites proved to be cost prohibitive.

Initial costing estimates for each Cellular backhaul link from the amount of data required at each village equated to be $10 per month per village. Each village system design incorporated the 3G Cellular modem to provide the backhaul of the data from each village to Cobar Shire Council offices, whilst a series of licence free wireless I/O IP based radios were selected to provide the local interface to each pump station & reservoir or tank. Licence free radios were selected at the villages due to being able to provide reliable wireless links over the shorter distances which were up to 10km in some areas.

The combination of IP based licence free I/O Radios interfacing with 3G modems allows Cobar Shire staff (and Indratel as the system integrator) to remotely diagnose all village radios down to each individual I/O point from Cobar shire or any of the villages providing a safe and prompt means for network diagnostics when required as lengthy trips to site can now be avoided.

The I/O based radios at each village were selected primarily to provide peer to peer communications providing a decentralized control in the event of any network outage further up the network which will ensure that services at villages are not compromised in the event of cellular network outages.

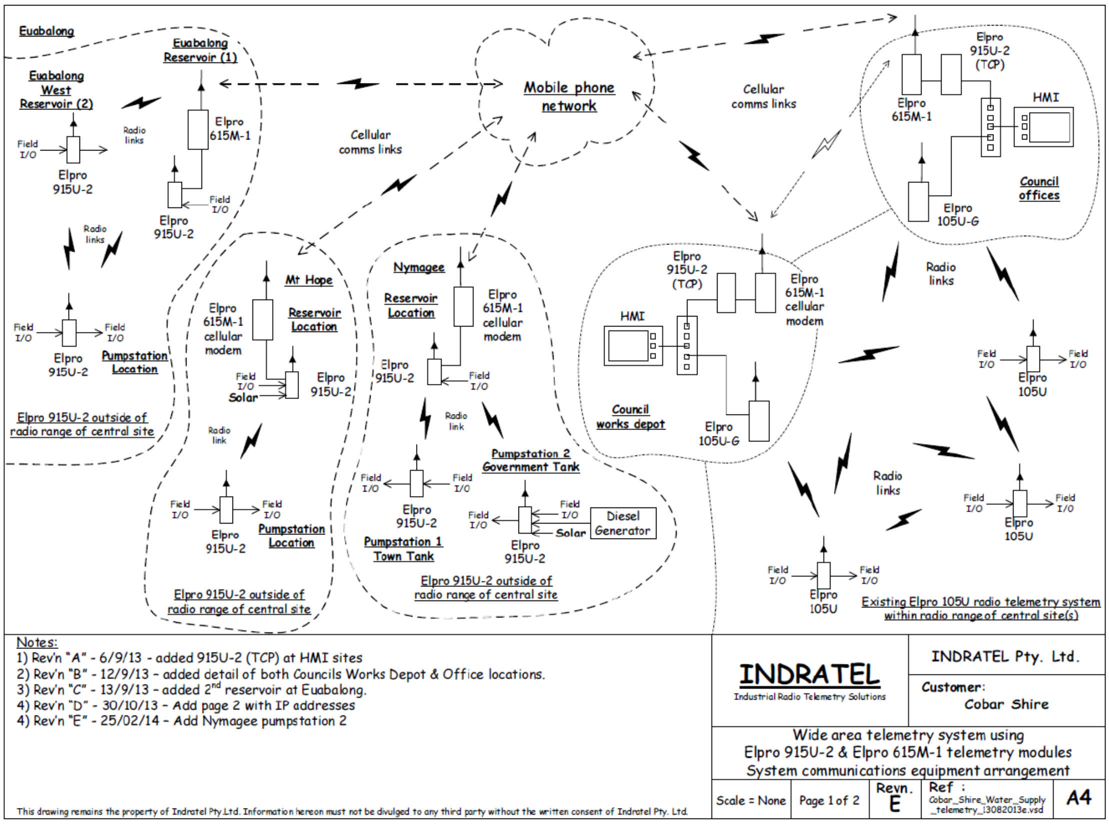

Figure 4: *Complete Network Design*

4.2 Application Summary

Overall costs to upgrade the existing Cobar and Water Board system were kept to a minimum by leveraging different wireless and wired technologies. The system has resulted in a reliable design and through the implementation of an IP based system for the outlying villages incorporated back into the HMI allowed for a seamless upgrade of remote villages without compromising the original existing I/O system so operators now receive real-time readings and diagnostics that are now managed from the centralised HMI located at Cobar Council offices.

5.0 CONCLUSION

Wireless networks in W/WW systems offer significant cost savings and operational flexibility as well as an increase in productivity and greater resource efficiencies; which has led to their wide scale deployment around the world. Smart installation designs leveraging multiple wireless (including cellular), and wired communications technologies and features, can deliver cost effective, reliable and robust systems. Working with experienced design and installation engineers will deliver seamless deployment and future proof the system for scalability as needs grow and technology advances. Operator safety, productivity and efficiency have been improved with less travel required to remote sites.