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USING TELEMETRY TO SUPPORT CHANGE IN MANAGEMENT PRACTICES

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ABSTRACT

Monitoring and controlling remote infrastructure, particularly water infrastructure, is an expensive and time-consuming activity on extensive pastoral properties. Remote infrastructure management systems use telemetry and specialised computer software to dramatically reduce the associated costs and potentially improve system reliability.

In addition to providing strong benefits to more efficient operation, a remote infrastructure management system can also be used to capture operational data to support research and changes in management practices, and compare the impact of changes in overall management practices.

As part of the system, a network of sensors can gather an array of environmental and resource consumption data into a centralised information database where station staff and researchers can perform detailed analysis.

Significant challenges are faced in operating telemetry equipment in an environment like that of Australia's tropical savanna rangelands. The equipment must be able to tolerate a wide range of temperatures, withstand strong seasonal weather and not succumb to the inquisitive beaks and foraging habits of native and introduced species.

INTRODUCTION

If intensification of the pastoral industry in Australia's northern savannas is to become a reality, more efficient and cost-effective ways of managing water points and associated infrastructure are required. As part of the Pigeon Hole Project, we have been developing tools to address this need. The first challenge for a telemetry system as part of the Pigeon Hole project was to address the issue of robustness and reliability of the equipment. For the research outcome to be useful to the pastoral industry, the equipment has to be both commercially viable but also capable of reliable operation in the harsh environment.

Whilst there are many commercially available telemetry systems, these were found to be unsuitable. Often existing products were intended for other industries that could tolerate higher prices or that didn't have the same constraints of environmental robustness and ultra-low power operation.

For this project, a commercial partner was found that had a partially developed system, which met many of our needs, and was also amenable to further enhancement to meet additional needs of the project.

ROBUSTNESS AND RELIABILITY

During the first two years of the trial, much has been learned about how low-cost, reliable telemetry equipment can be manufactured on a commercially viable scale. Several iterative improvements in overall design have been required to cater for issues from water ingress through condensation to ultra-violet light damage and protection from the alarmingly strong beaks of the native bird-life.

Reliability of any electronic system depends on reliable power supply. Since the remote units are far from conventional power sources, much effort has been invested to ensure that the system can operate as efficiently as possible on the available solar power. This is particularly an issue during the extended wet season, when it is not unusual for a remote unit to experience many consecutive days of overcast conditions. Detailed power consumption analysis has been performed (Figure 1) to better understand how units perform under different environmental circumstances and how best to operate high power equipment such as the radio in order to optimally balance system responsiveness, currency of information and long-term reliability.

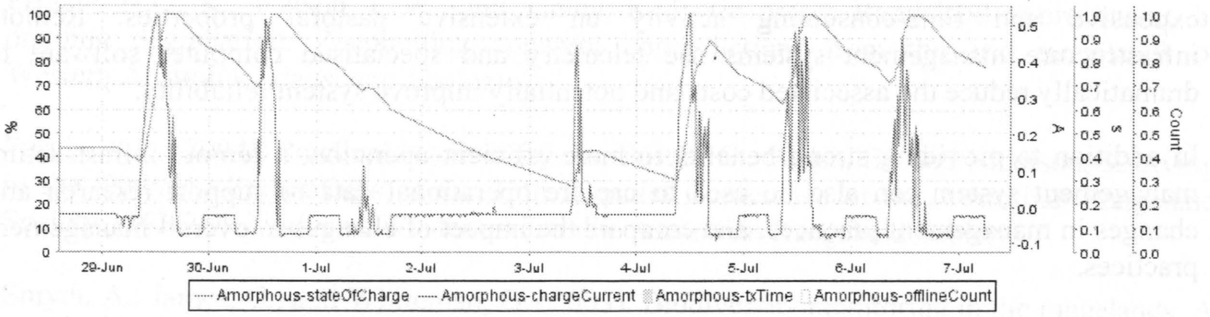

Figure 2: Graph of power consumption characteristics.
Solar input and battery state of charge iver time

WIDE-AREA ACCESS AND TELECOMMUNICATIONS

The second challenge with the trial was to ensure that the system could cover very wide geographic areas, in the absence of telecommunications infrastructure. Many different options were considered for the communications backbone, and UHF was selected due to its maturity and wide adoption in the pastoral industry. The fact that low-cost, low-power, reliable components were available further enhanced the commercial viability of the system.

The terrain in pastoral production areas can at times be unsuitable to radio communications, so it was essential that the system could also take advantage of repeating techniques to bridge larger distances between equipment and/or work around topographic obstacles.

The resulting design is such that each node in the telemetry network can act as a repeater for any other. In this way, the communications reach of the telemetry network is effectively unlimited, and is able to route around unfavourable terrain, or use favourable features such as ranges and high-peaks to increase the overall coverage of the telemetry environment.

Alternative communications media, such as satellite, low power 900 MHz spread-spectrum radio and WiFi were considered, however all fell short in cost, robustness, availability and or coverage These decisions will of course be revisited in the future as other communications technologies mature.

DATA RESOLUTION, RECORDING & CENTRALISATION

Another important requirement of the telemetry system was high resolution of recorded data. Commercially available systems often were only able to differentiate between set points such as high/low, with no absolute measurements or accuracy of recorded data. Furthermore we required that the system was capable of recording data for later analysis. Many systems were unable to record data at a sufficient resolution to make the historical recordings useful.

Over the length of the trial, we have developed a sophisticated system of two-stage information gathering and recording. Remote units can be configured to take high accuracy measurements of any connected equipment. Recorded values can be absolute or relative and can be recorded by comparison to thresholds or at regular intervals.

Observations are first stored on the remote unit to ensure retention of the data even in low power situations, or in the event of communications failure. When appropriate or on demand, the data logs from any unit can be synchronised with a central database, where the entire history of each unit is collected and available for detailed analysis. The automation of this data collection represents a significant advance in telemetry systems and will enable the gathering of vast amounts of data to support research and the analysis of the impact of changes.

OPERATIONAL CHALLENGES

One of the greatest challenges faced by the telemetry side of the Pigeon Hole Project has been the deployment of the system in an operationally viable manner. Often, new technologies lack the practical considerations of more mature equipment. For the research project to be successful, the equipment needs to be installable to maintainable by station staff without the need for lengthy training.

Equipment also has to be robust. Stations are tough environments; the trip out to a bore to install the equipment will often be in the tray of a 4WD ute, over very rough terrain. Equipment must be both physically and electronically robust.

HUMAN FACTORS

For the system to be successful, it must have utility to the widest array of people. From station staff to researchers, the software that exposes the system's functionality has to be simple to use and obvious in its operation.

Given the importance of stock water supply, the system must provide station staff with a high level of confidence if they are to trust it enough to reduce the number of times each water point is actually visited. Different techniques have been tested to help build user confidence in the information presented by the system. The most successful to date has been to make historical data easily available for each sensor in the system, and to allow data from multiple locations to be shown together.

Significant effort has been invested to explore appropriate ways to represent information in a timely and obvious way. Most importantly, whenever the system has detected a situation that requires intervention, the form of notification is critical, and must not be obscured by non-critical data.

The system employs a familiar paradigm of colour coding alarms and other notifications, to make it easy for almost anyone to determine if the system requires attention (Figure 2).

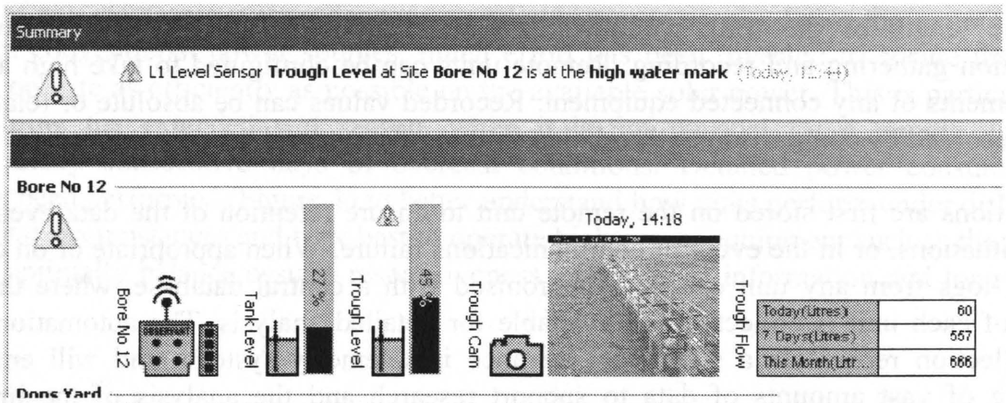

Figure 3: Use of colour to indicate severity of notifications

Recent research has commenced with the introduction of a touch-screen kiosk, with the possibility of installing it in a high-traffic areas such as a staff kitchen. By using carefully designed information presentation and making the interface simple to use, we hope to greatly increase the likelihood of station staff making heavy use of the system, and enabling the widest possible range of participants. In this way it is far more likely that the system will meet its objective of reducing visits to remote infrastructure and increasing the efficiency of station operation.

SUPPORTING RESEARCH

The system installed and operating at Pigeon Hole is recording a significant amount of information from a wide range of sources. Seventeen water points have equipment installed that is recording information such as rainfall, dam and trough water levels, volume of water flow from bores as well as detailed operational statistics on water medication equipment.

To date, limited amounts of this data have been made available for analysis, but over the coming months and years, the amount of information recorded will steadily grow and form a comprehensive picture of many aspects of station operation.

As an example, a simple analysis that can easily be supported would be to look at the correlation of medicated water consumption versus rainfall. It would be logical to assume that in times of high rainfall, livestock will find other sources of water, and may not make use of stock water supply points during these times. The system takes accurate recording at intervals of 15 minutes or less, so a very detailed picture of water consumption can be developed.

REMAINING CHALLENGES

Some significant challenges remain before the telemetry system can be considered a success. The biggest is to develop a methodology to quantify the benefit of installing such a system. At present, all notions of cost savings and time efficiency are anecdotal at best.

With the system now substantially in operation, another significant challenge is confirming its utility in supporting the other research being conducted in the project. To date, significant amounts of data have been recorded, but no detailed analysis has been performed. Incorporating feedback from such activity will significantly improve the system.

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