Implementation of 'edge sensors' into mining operations

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INTRODUCTION

Most sensors used in mining operations have not materially changed since the middle of the last century. Most are still configured to have a sensing and signal converter/transmission module, allowing integration into a local or site-wide control system.

With the significant increase in computing power, miniaturised solid state memory and rapid drop in cost of both, it is now possible to perform complex, data intensive calculations in the sensors themselves, rather than pushing 'big data' or communicating analogue signals to centralised control systems.

The practice of processing data near to where it is generated is not new - 'edge computing' in the form of Programmable Logic Controllers (PLCs) has been used for decades in the industry, often coupled with a Distributed Control System (DCS), where feasible. This practice, however, is largely dependant on a closed proprietary architecture and integrating this into 'traditional' Information Technology (IT) systems is challenging, without compromising cyber security.

Standardisation of cyber security protocols in the minerals industry for Operational Technologies (OT) to interface securely with IT systems still seems some way off and is likely to be adopted from another industry sector. Wireless technologies can add an additional layer of complexity and security risk; however, this can be mitigated by utilising often already existing secure wireless mobile data communications though trusted network operators.

Using 'edge sensors' with sufficient solid-state memory, means that a loss in mobile communications need not be critical, provided the instrumentation is clustered through physical connections and localised control algorithms, similar to a PLC architecture. The sensor is capable of operating without a connection and once re-connected, can upload the missing data in addition to the new data to the cloud server. Cyber security is provided though the carrier's encryption of the mobile data connection and can be further augmented by running in a Virtual Private Network (VPN), if need be.

This does not preclude integration of 'edge sensors' using traditional wired communication protocols, particularly on sites that already have existing control systems in place. What it does allow is the processing and transfer of intelligent information, and enabling historical data analysis and alarming, which has only been commercially justifiable at larger mining operations.

WHY THE FOCUS ON INTELLIGENT SENSORS IN MINING?

The mineral processing industry has been relatively poorly serviced with sensors that are fit-for-purpose in an abrasive environment. Equipment designed for the larger market segments, like water treatment, oil and gas, food processing, etc is at best adapted into the mineral processing industry, often with mixed success.

This has several key impacts on how automation is then used in that industry. If the reliability or repeatability of a sensor cannot be maintained, trust in that instrument and any subsequent control algorithms is greatly diminished and it is not uncommon, for this reason, to see up to half of control loops in a centralised control room sitting in manual control. Even for well automated plants, control becomes reactive and dependant on operator skill, attention and intrinsic processing knowledge.

In most industries this would be unacceptable, as the operational risks from running in such a manner increase the likelihood of catastrophic incidents that often would have impacts beyond the limits of the operation. In mineral processing this means of operating is often tolerated, as the consequences

are typically seen to be efficiency related, which is often difficult to quantify in a timely manner with complex geo-metallurgy and highly variable feed. Plant throughput is still the key performance driver for most operations, however, that should not be confused with process efficiency or maximised profitability of operations. Increasingly, the industry is realising that the lack of efficient process control and reliable sensors is not only an undefinable efficiency risk, but can significantly contribute to external risks, made more obvious globally, by catastrophic tailing storage facility containment losses in more recent times.

The Processing Program within CSIRO Mineral Resources looked at this challenge, and in consultation with stakeholders, identified numerous areas that were poorly serviced by the automation and sensor vendors. As part of that scoping study, at least one third of Australian mining operations do not have a centralised control system and rely on fully manual control, or at best, on processing equipment vendor PLCs for localised control, typically focused on a single piece of equipment. Another third of operations may have some level of process monitoring (usually a third-party SCADA system that can communicate with these equipment vendor PLCs), but typically do not have 'centralised control' as such. It is only the top third of operations that have the DCS, data management and operational historian infrastructure that would be common in other processing industries.

TIME FOR EDGE SENSORS

The benefits of 'edge computing' (like PLCs) have been well documented and demonstrated in nearly all industry sectors. Being able to process data near the point of generation reduces the latency between the devices and the processing layer allowing faster response times and decision making out in the operational domain. The integration of data visualisation, trending and alarming until recently relied on relatively expensive infrastructure, even when using third party SCADA systems, rather than true DCS 'historian' applications. This makes process optimisation and monitoring through trending, difficult to justify as an investment case, even on a relatively well instrumented plant.

Beyond the traditional wired communication protocols, it is possible to retrofit existing localised PLC control with wireless or mobile communications. Many vendors of newer PLCs have this capability already built in, but in either case there is a strong reluctance to adoption, given the lack of cyber security standardisation. There is every expectation that this will be resolved eventually, but the OT/IT interoperability divide still limits its acceptance, even in more progressive industry segments.

In the meantime, technology is progressing at an ever-increasing rate and several key factors are now pushing the progress of 'edge processing'. The cost point of always-connected processors that take advantage of relatively cheap and VPN secured mobile data connection is dropping rapidly. Coupled with cheap and more powerful computational capability and sizable local solid-state storage, this allows large amounts of sensor data to be distilled into 'intelligent data'. This in turn minimises the amount of data that needs to be transmitted, and importantly, allows for the display of computed data, trends and alarming locally, which is important for operations that do not have a control room and rely on operators walking rounds. Using 'intelligent data' does not preclude downloading the raw, unprocessed data stored on the local 'edge device' that can be set up so that can be accessed remotely and on demand for the periods of interest, rather than as a matter of course.

Technology has evolved to a point where it is now possible for each individual sensor to be integrated as an Internet of Things (IoT) device talking via a VPN to a cloud-based data repository. Using inexpensive encrypted mobile wireless communication, together with integrated computational capability, allows inexpensive real-time monitoring, alarming and trending, without the expensive infrastructure costs associated with traditional site-wide control systems. These 'edge sensors' can then form hubs for other legacy sensors (that don't have wireless or indeed any connectivity), expanding the overall data set available for process optimisation and potentially routine control functions. This 'intelligent' information can then be displayed on one organisation-wide, customisable IoT dashboard, that is platform agnostic and, with appropriate security protocols in place, can integrated with Enterprise Resource Planning (ERP) software, where applicable.