IoT dashboard implementation into mining operations using encrypted wireless mobile telecommunications and cloud infrastructure

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INTRODUCTION

The value of timely decision making, system optimisation and continuous improvement is well understood from productivity achievements gained in industries more broadly. Mining operations are increasingly becoming data rich but remain relatively information poor. Getting information to key people who can drive improvements and translate that to value is the critical step in the industry's digital transformation.

Information systems can now be implemented that allow fit-for-purpose visibility of high value operational issues using one-directional passive information flow to Internet of Things (IoT) dashboards though encrypted wireless mobile telecommunication networks and cloud infrastructure. This becomes a viable alternative to the trending and historian software solutions typically offered by higher-end Distributed Control Systems (DCSs) for high value data streams. The cloud servers hosting the dashboards can be accessed using non-proprietary intranet browsers and can generate reports, provide downloadable data and notify key decision makers through a hierarchy of notification. The IoT devices are sensor agnostic and can easily be integrated with legacy equipment commonly found in long life-of-mine operations. This adjunct solution allows improvements to be driven at the supervisor or shift level. Thresholds can be set, and day-to-day decisions made, using evidence-based data and trend analysis.

INTERFACE LEVEL DETECTION ON A FLOTATION CELL

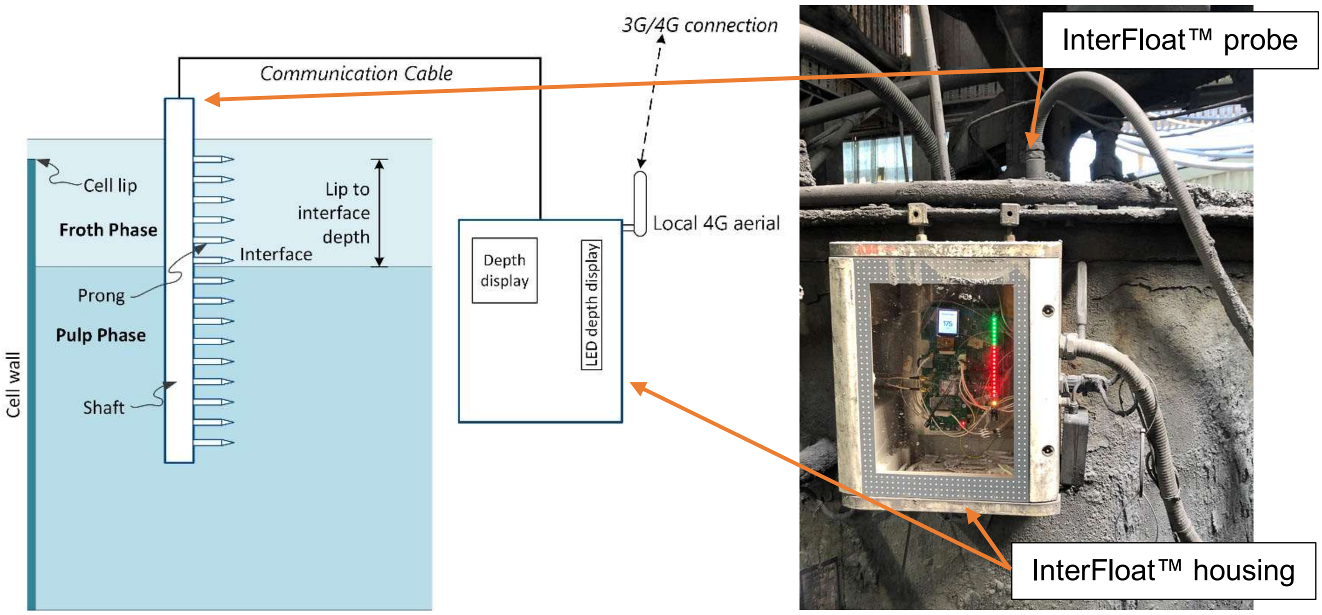
Since purchase in 2009, Mandalay Resources have restarted capital development and mining at the Costerfield gold-antimony mine in central Victoria, Australia.

While operations have seen significant improvements in mining and processing methods since 2009, showing sustainable production going forward, the Brunswick plant operations at Costerfield are low in instrumentation, which increases the challenge of monitoring, control and improvement.

CSIRO Mineral Resources identified an opportunity to trial level detection instrumentation on the tank flotation cell, which to that point relied solely on two-hourly operator manual measurement. A CSIRO InterFloat™ level detection device (FIG 1) was installed to detect the interface between the pulp and froth phases, a key parameter to allow cell optimisation of the flotation process and mineral capture.

The InterFloat™ device consists of a shaft with multiple prongs, mounted to the side of the flotation cell, and is designed sufficiently long to cover the expected operation levels on either side of the pulp and froth interface. The gas build-up at each prong is used in an embedded advanced algorithm to detect the interface and is enhanced using the conductivity at each prong.

The device is fitted with an LED and LCD display and has enabled continuous local visualisation of the interface level (depth) since installation in December 2018.



(a) (b)

FIG 1 – (a) Graphic representation of the InterFloat™ level detection device, and (b) photograph of the prototype InterFloat™ Mk1b version installed at Mandalay Resources.

ENABLING MONITORING AND TRENDING

While the InterFloat™ device can provide 'traditional' outputs as a 4-20 mA signal, the Costerfield operation cannot currently utilise this functionality as they do not have an integrated plant-wide control system (they are in the process of implementing one progressively). CSIRO had already built 3G data communications into their unit, for 'Over the Air' (OTA) firmware upgrades and performance monitoring. With this connectivity already in place, Clarity Advanced Control (Clarity) took the initiative to develop an alternative means of providing real-time depth monitoring and trending.

The current Mk1b version pushes raw data and instantaneous depth, via encrypted 3G protocol, to an established internet cloud service (AWS server) every 30 seconds. Finer details of the raw data are collected more frequently locally on a removable storage device. This data can be used for detailed diagnostics and allows data transfer to 'catch-up' should the wireless communication be interrupted.

A client-side script was created to convert the cloud-based raw data and instantaneous depth to an exponential weighted moving average. The key parameters (instantaneous and moving average depth), as well as the mobile signal strength, are written to a SQL relational database, which also stores the device's configuration data.

Clarity developed an IoT dashboard (FIG 2), with backend SQL database, which can be accessed via a standard, platform-agnostic web-browser, and connected to the cloud-based SQL database. Mine operations have been given secure access to the dashboard to enable an uncluttered overview of the instantaneous depth (blue) and moving average (orange) over a chosen time period (main graph). The previous 24 hours' operation are shown in FIG 2, while longer timelines of a month (FIG 3) and a year can be used to monitor longer-horizon effects. Additional insight is provided via the top panels and sub-graph providing averaged response over various time periods. The right panel shows operating bands for the chosen viewing period. An event log is included and currently reports on loss of power and 3G signal strength, which at times can be problematic at this mine site.

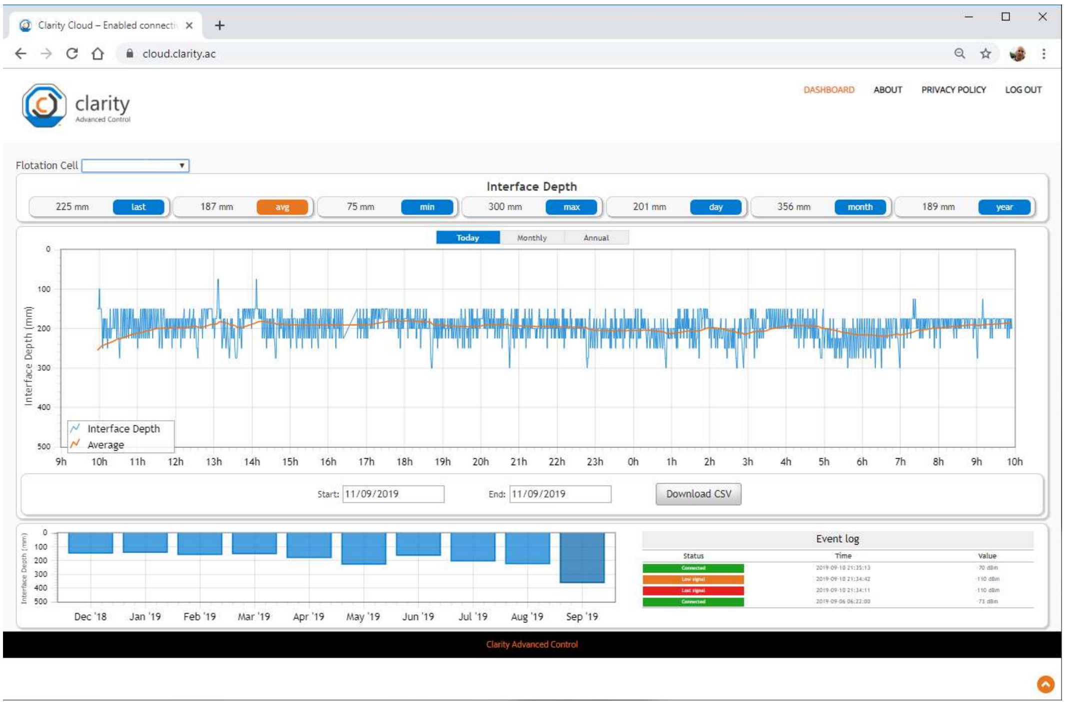


FIG 2 – Default webpage dashboard layout, showing flotation cell operation over a 24-hour period.

FIG 3 – Flotation cell operation over the past month, showing plant disruptions 17-21 August and 5-10 September, and diverted operation on 2 and 3 September.

IMPACT AND FUTURE DEVELOPMENT

An IoT dashboard has been created and configured to provide information that the client wants and needs, based on the site, instrument and application. The implementation has enabled mining operations, who don't have any control or monitoring infrastructure, to access succinct information, anywhere and anytime, to monitor the depth trend in real-time on a laptop or smart phone device via a secure platform-agnostic web-browser, without having to commit to significant capital outlays.

Unlike traditional historian infrastructure that relies upon an expensive DCS system, Clarity's IoT access to data has enabled rapid, inexpensive deployment that can be customised to suit mineral processing operations.

Further value can be added by showing best-practice operating bands with the potential to raise an alarm or warning message, which can be pushed for instance to a computer, smart device or SMS. Extending this type of dashboard to integrate legacy equipment, commonly found in long life-of-mine operations such as the Costerfield operation, further enables monitoring and optimisation of operations.

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