INTERNATIONAL MINING Technology 2018

HALL OF FAME

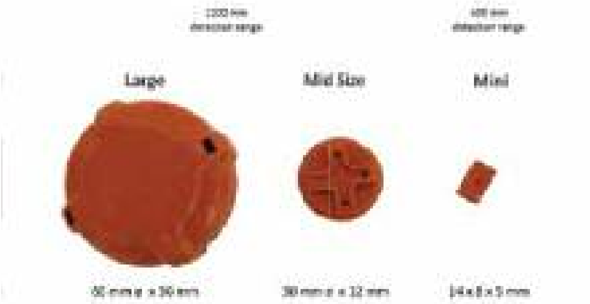
Michael Wortley[1], Kai Riihioja[2] Jose Luis Bravo[3] & Rodrigo Sales[4]

UNDERGROUND PRODUCTION

The Metso SmartTag has great potential in tracking ore in caving applications. However, it also has myriad applications underground and in surface mining (particularly in managing fragmentation) and plant operation. It is a radio frequency identification (RFID) based technology designed to allow tracking of ore from its source through blasting, run-of-mine (ROM) pads, crushers, intermediate stockpiles and finally into the concentrator.

Successful applications of the SmartTag system have encouraged development to allow the system to be used in a wider variety of plants, in particular plants with finer crushing and screening stages.

This presented Metso with a number of technological challenges, including RFID tag and antenna design. By reducing the traditional RFID tag diameter from 60 mm to 13 mm the RFID tags can now successfully pass through a tertiary crusher. The new smaller RFID tags (referred to as mini RFID tags) have been used in some Process Integration and Optimisation (PIO) projects with very promising results.



The results indicate that the miniature RFID tags have a higher survivability to blasting and through secondary crushing stages. Extending ore tracking further through the process allows more reliable linking of spatial data with time based process performance. Metso is looking at developing even smaller micro RFID tags, and is also investigating other applications for the SmartTag system, including ore tracking from the original source to the final destination (i.e. from the mine, through the plant and ports to the customer).

Metso's Process Optimisation (PRO) group is a world leader in mineral processing consulting. A significant amount of this consulting work involves PIO studies, which includes investigating the effects of drill and blast design and implementation on downstream processing. Critical to these studies is the ability to track specific ore into and through the plant. Hence the development of the SmartTag system.

The benefits of using SmartTag include:

- Linking spatial mine data to time based processing data
- Increased confidence in ore blending
- Proactive process changes for known ore types
- Accurate measurement of residence times in stockpiles and bins.

Since 2007 there have been significant advancements with RFID technology that has allowed PRO to extend the reach of SmartTag beyond secondary crushing to tertiary crushing and beyond. Mini RFID tags have been critical to this.

A SmartTag RFID tag travels through a mine and mineral processing plant in the following steps:

1. The RFID tag and insertion location is logged using a hand-held computer or PDA

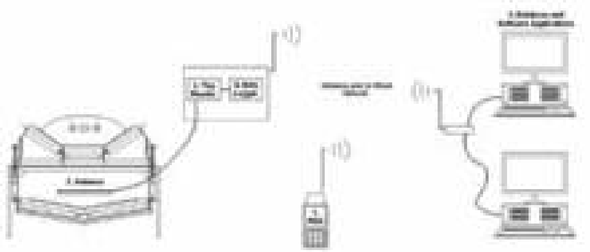
2. The RFID tag is inserted into the ore (e.g. into a blasthole)

3. The RFID tag travels with the ore through digging, transport and processing

4. The RFID tag is detected at detection locations (on conveyor belts) and the time and RFID tag recorded

5. The RFID tag data is loaded into a database and analysed as required.

To achieve this, the SmartTag system requires five main components, which are shown below.



The first component in the SmartTag system is a PDA, which allows the initial RFID tag insertion process to become more efficient and accurate. Each RFID tag is added to the database using one of three options:

1. The RFID tag is associated with a GPS coordinate
2. The RFID tag is associated with a predefined point (such as a blasthole)
3. The RFID tag is associated with a new point, which can be accurately located later.

At present the system does not allow for high precision GPS but it can locate the nearest point in a series of predefined points, such as blastholes, and allow the user to associate RFID tags with these points.
The next component in the system, the antenna, is located at

the conveyor belts. The antenna both induces a charge on the RFID tag and also receives a transmitted signal back from the RFID tag. The design of the antenna is decided by two parameters, which are its size and its robustness. The size of

to charge the RFID tag should be as large as possible; therefore, the antenna used for the SmartTag system is the largest available for this frequency of RFID system.

An RFID reader then decodes the signal from the antenna and determines the ID of the RFID tag passing the antenna. Later versions of the readers also have auto-tuning capabilities which ensure that the maximum possible read distance is achieved at all time. In the SmartTag system the reader then transmits the ID using serial communications.

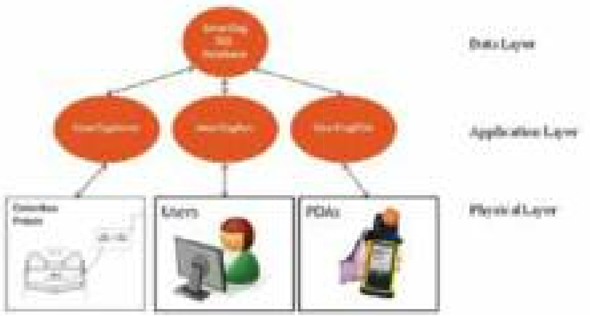
A data logging or buffer stage improves the reliability of the systems and also makes movable systems possible. The data logger receives data directly from the RFID reader, stores the IDs with the time they were detected and monitors vital system parameters, such as the tuning state of the antenna. The data logging stage also makes SmartTag less reliant on communication links (such as wireless) as the data is stored at the detection point until a link is established to the software applications. The critical communications links, like the one between the antenna and the reader, are all wired and very reliable.

The core of the SmartTag software is an SQL database. The database, located on a dedicated server, stores all the information about the detection points, detected RFID tags and original locations.

There are several SmartTag software applications which either input data into the database or use the data to output information, including:

- SmartTagServer – reads data from the data loggers
- SmartTagPDA – exchanges data with the PDAs and translates site **blasthole layout diagrams**
- SmartTagRes – calculates the residence time between two detection points.

The flow of information between the database, applications and physical hardware is shown below:



The value delviered by SmartTags has been further enhanced by the development of an automated geometallurgy software package called GeoMetso™. The software package can autoamatically combine process and mining data when a tag is detected. The result of this is accurate relationships between rock charateristics and process performance. Results show that significant gains can be made by planing and feeding the plant based on the geometallurgical properties, quantified using GeoMetso, of the ore rather then the traditional mining parameters.

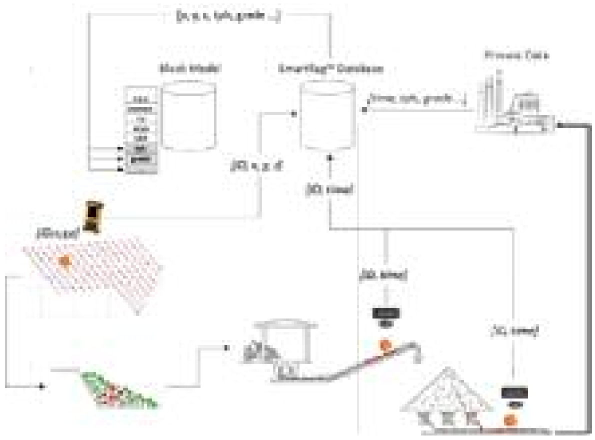
Geometallurgical modelling of an orebody provides benefits to a mine by gaining a better understanding of the ore characteristics and how these affect the performance of the concentrator. With this knowledge, plant operating conditions can be adjusted to optimise throughput and recovery in advance of the arrival of particular ore types. being processed is known as accurately as possible. Depending on the homogeneity of the ore characteristics, reliance on assumptions about stockpile residence times, scheduling and material handling can render the best geometallurgical models useless.

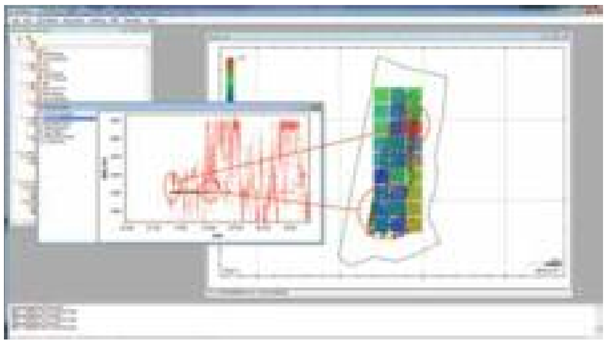
The solution adopted at Kittilä mine in Finland was to use Metso SmartTags and in-house expertise to develop a system that continuously and accurately links geotechnical and lab data from the mine to the performance of the plant. This application presented several unique opportunities and challenges. For example, this was the first installation of a SmartTag system for geometallurgical modelling in an underground mine. Challenges included the fact that the system installation is routinely subjected to temperatures below minus-20°C.

The system was installed and commissioned in early 2013 and has been operating continuously since. Kittilä saw the benefits of the system with an increased understanding of how different ores are processed in the concentrator. Other advantages include the ability to alert operators about the arrival of difficult ores and a better understanding of their ore handling systems.

The system has led to improvements in Kittilä's reconciliation and metallurgical accounting and provides a method to predict head grades, in real time, without the need to wait for plant assay results. The system also allows the geology department to warn the plant about problematic ore types before they cause processing issues.

Reference: Geometallurgical Modelling and Ore Tracking at Kittilä Mine by D La Rosa, L Rajavuori, J Korteniemi, M Wortley, from Orebody Modelling and Strategic Mine Planning 2014, Paper Number: 19





Correlations between mill throughput and ore source at Kittilä

1. Global Manager – PRO Products, Australia
2. Senior Software Engineer, Australia
3. Senior Instrument Engineer, Chile
4. Senior Product Engineer, Brazil