

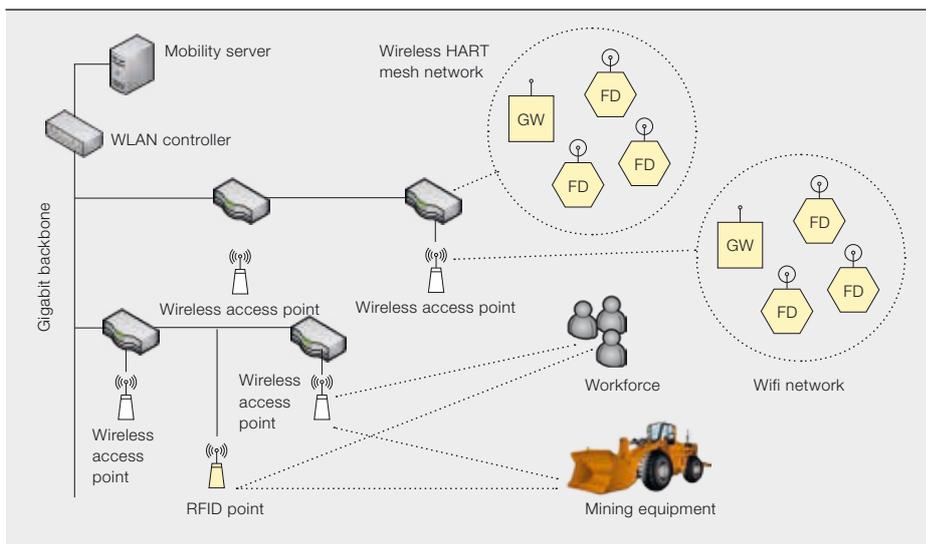


# Mine of information

Integration of mobile equipment in underground mining

STEFAN L. SJOSTROM, KJELL G. CARLSTEN, KRISTER LANDERNAS, JONAS NEANDER – Unsurprisingly, most easy-to-find high-grade metal ore has already been extracted from the earth. This means that mining companies have to work harder to mine those remaining resources. There is, however, an area of technology that is less advanced in mining than in other industries that offers scope for significant increases in operational efficiency and profitability. This is the area of automation and data integration in the underground mining environment. The lack here of the technical sophistication seen in other industries means that optimization of the entire value chain, from mine to mill, often remains a pipe dream. However, ABB delivers systems that allow miners to optimize the utilization of underground mining equipment, increase mine productivity and reduce energy consumption.

**1 A fully integrated network gives the operator a comprehensive view over the mining process. (FD = field device; GW = gateway.)**



increase mine productivity while reducing energy consumption. ABB's Extended Automation System 800xA platform and associated products facilitate such mine automation and data integration.

control over, the different operations in the mine. It also results in the inability to optimize the entire value chain, from the mine face to the mill. One reason for this deficit may be that the mining industry has not yet faced the same cost reduction and output optimization pressures as other comparable businesses.

**M**ining was one of the very first industries developed by humans. Indeed, the oldest known mine is the Lion Cave in Swaziland, where pigment ingredients were mined and which radiocarbon dating shows to be about 43,000 years old [1]. Other mines, of similar age, yielded materials for toolmakers. Although mining has become highly mechanized over the last century, the uptake of technology in mines generally lags that in other industries, like oil and gas or pulp and paper. However, as ores and other desirable deposits become more troublesome to extract, increased automation and data integration become ever more important for successful mining.

ABB's underground mining offerings allow real-time data from underground equipment of different types and manufacturers to be integrated into the System 800xA open process control system → 2. This allows for better visualization and utilization of the equipment fleet, including machine location tracking, machine status reporting and relaying of actual operating environments underground. The design and implementation of such systems, including the selection and direction of information to drive business performance, is a critical competitive advantage.

The situation, however, is changing rapidly and the best way to bring about improvement is to introduce a flexible and multi-functional communication system into the underground mining environment.

In parallel, employee skill levels have to rise to facilitate this expansion in technology. Appropriately qualified operators are needed for product and process optimization, maintenance planning and environmental control. Overall, there will be fewer, more skilled employees and they will cover the entire value chain. It is likely that some of these operators will be able to control several mines – assisted by sensors and automated systems that deliver, via a communication backbone, the real-time information necessary for controlling each product and process → 1. This integration allows the mine to optimize the utilization of underground mining equipment and

**Mine automation**

In general, many operations in a mine are reasonably well automated in themselves, but their integration with a master system is often poor or wholly absent. This results in suboptimization and an inhomogeneous perspective of the process.

A chief contributor to this deficiency is the lack of a versatile communication infrastructure, wireless or wired, in the underground mining environment. This makes it difficult to obtain an overview of, or full

**Communication**

Traditional UHF/VHF radio has been used extensively for voice communication in un-

**As ores and other desirable deposits become more troublesome to extract, increased automation and data integration become essential to successful mining operations.**

derground mines for many years. But this communication method lacks adaptability and functionality. A wireless local area network (WLAN) is a much better solution. Indeed, several mining companies (eg, Swe-

**Title picture**

Although much has changed in the mining world, more automation and data integration is needed.



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Once a communication infrastructure is established underground and mobile equipment is computerized, entirely new worlds of data exchange possibilities open up.

den's LKAB and Boliden) have installed WLAN networks underground. Such networks are most commonly used for voice over IP (VoIP) telephony and data transfer, but they also enable tracking of, and communication with, mobile equipment.

### Tracking

A tracking capability allows the location of a smartphone, laptop, radio-frequency identification (RFID) tag or embedded device to be established. Tracking can be performed using any WLAN client. Usually, the location is obtained by calculating the position of the client relative to some fixed location or anchor points with known coordinates (often the WLAN access points). Then, this relative position is transformed into a global and absolute coordinate system. In general, the more numerous the anchor nodes are, the higher the localization accuracy will be.

So that functionality such as tracking will work reliably, care must be taken when planning and deploying a wireless network underground. One major challenge is the demanding radio environment found in underground mines – eg, gallery topology, variable geology, signal attenuation in rock and construction materials, wattage versus intrinsic safety, and electromagnetic interference. ABB has performed several field trials to showcase relevant technologies and has pilot installations that demonstrate tracking of mining equipment underground.

### Mobile equipment integration

Once a communication infrastructure has been established underground and the mobile equipment fleet has been computerized, entirely new worlds of data ex-

change possibilities open up. For example, drill plans and loading sequences for the production machines can be delivered to them and the results of their actions reported back online. The integration of mobile equipment into the production control system has other uses too:

- To deliver the results of the initial steps of the mining process (geology, ore calculations, mine survey, mine design and production planning) to the mobile equipment systems in a useful format.
- To retrieve the results reported by the mobile equipment, such as online production status and production reports, analyses and statistics, and relay them to the relevant users.
- To retrieve execution statistics and maintenance data from onboard systems. Some of this information is used by the process control system and some (mainly the maintenance data) will be transferred to, or collected by, other entities, such as the maintenance system.
- To monitor the online status of mobile equipment, including localization information.

The interfaces to the production control system are based on industry standards. The interface between mobile machines and the open ABB process control system is OPC, specifically OPC Data Access (OPC DA), which deals with real-time data, OPC Alarms and Events (OPC AE) and OPC Historical Data Access (OPC HDA).

Data sets and naming of items conform to IREDES, the international rock excavation data exchange standard. This governs data exchange between mining equipment and office computer systems and defines

ABB's cooperation with Atlas Copco is an excellent opportunity for both companies. As each partner will focus on its core competencies, the joint development will create a lot of added value for underground mines.

"Our future mine operators want a compelling, all-in-one information center to optimize the utilization of our machines underground. I am sure this project will take a big leap forward in optimization of underground mining."

**David Shellhammer**  
President at Atlas Copco  
Underground Rock Excavation

## Several mining companies have installed WLAN networks underground for VoIP telephony and data transfer, but they also enable tracking of and communication with, mobile equipment.

one common electronic language for mine automation systems.

#### Mine online: mobile integration

The location information and other data from mobile equipment are obtained via the WLAN infrastructure. After consolidation, they can be viewed in the open ABB process control system. This combined information provides the basis of an accurate and online representation of ongoing activities and mining progress. Output of this analysis helps provide further optimization in different areas:

- Instead of following a predetermined routine, the ventilation control will behave to accommodate actual conditions and needs as deduced from the mobile equipment status.
- The mobile equipment availability will be improved as the asset monitors combine data from the machines and from the process environment to accurately schedule maintenance.

the surroundings (traffic situation, status of production equipment, etc.) can be compiled and made available to mobile machine operators will increase their ability to make intelligent decisions when plans and reality diverge, as they often do in the mine environment.

#### Pilot installation

ABB and Atlas Copco Underground Rock Excavation, Sweden (Atlas Copco) have developed an innovative mobile integration system involving ABB's System 800xA automation platform and Atlas Copco mining machines. A successful pilot installation was demonstrated in June 2012. The solution is currently installed at the Atlas Copco test mine in Kvarntorp, Sweden → 3. This technology will offer mine operators unrivalled process control opportunities and information.

The project integrates important data from Atlas Copco underground drill rigs, loaders and trucks into ABB's System 800xA platform for better visualization and utilization of the machine fleet. By tracking locations of machines, their status and actual operating

conditions underground, this solution will provide the information needed to help mine operators make the right decisions at the right time and keep production running as smoothly as possible. In line with customer requirements and future mining demands, Atlas Copco and ABB will continue to develop and add more functionality to this concept.

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## The solution will offer future mine operators unrivalled process control opportunities and information.

- The way the mobile equipment adheres to the activity planning can be monitored online and deviances used as input when recalculating the activities.

In the future, the control loop could be closed to automatically redirect or re-plan mobile equipment, when needed. Already, the mere fact that information regarding

#### References

- [1] Mining. Retrieved 26 September 2012 from <http://en.wikipedia.org/wiki/Mining>