



HAPHAZARD to

SHIPSHAPE

Dr-Ing.
Andree
Röttig
and Chris
McElman,
Modular
Mining
Systems,
Inc., US,
discuss
advances
in, and uses
of, location-
based
technology.

“Where are my keys?” How often do you say this and wish you had a computer-aided location system in your house to help find your lost keys? Although this sounds like something from a science fiction novel, it’s more realistic than you realise. In fact, this technology is already here. Location-based technology is sneaking into our world in many forms, from cell phones to cameras with built-in GPS receivers.

So how does this pertain to mining? Replace the keys with a mobile pump or pickup truck in an open-pit mine. Substitute the loss of your keys with speeding events or excessive braking. Wouldn’t it help to know when and where

these events occurred, and where this equipment was located? To relate these questions back to your lost keys... Imagine the time and frustration avoided if you could determine where and when you usually lose your keys?

Analysis of location-based events can help to develop strategies to find your keys more quickly, or in a mining environment, to develop maintenance strategies for equipment that operates in especially rugged conditions.

Let's explore current mining applications for position information, parallel industry trends, and potential applications for location information in mining.

Mainstream trends

A current catchphrase is 'Location-Based Services' (LBS). These services generally consist of a mobile device, which can provide positioning information, and a mobile communications network. Within this framework, location is the main driver for the decision making process and value-added information delivery. For this discussion, we will use location-based services and location-based applications synonymously. Nevertheless, the web-based service is very often the preferred option. A good example is a truck fleet management system that sends a truck to the nearest gas station with the cheapest rates in the region. The recurrent principle in all these services

and applications is simple: position data is coupled with qualitative (or descriptive) information. In our example, a database of all gas stations with updated prices in a region adds valuable context to a money-saving decision.

In order to create these services we need the enabling technology-position determination. There are many potential solutions with differing complexity and precision, including:

- GPS receivers.
- RFID tags.
- Triangulation based on cell phone towers.
- Region locator on the internet based on IP numbers.
- Logical locations.

GPS receivers have become very affordable and therefore these chipsets (such as the SiRFstar™ manufactured by SiRF Technology) are increasingly built into mobile devices as part of the default configuration. Examples include:

- In-car navigation devices.
- Personal Digital Assistants (PDAs).
- Cell phones.
- Digital cameras.

Today, the cell phone is an indispensable tool. Within the market for personal GPS devices, many believe that the cell phone industry will experience the most significant

impact. Research indicates that by the end of the year as many as 63% of phones sold in North America will have built-in GPS chipsets.¹

So what is the driving force of this trend? The demand is broadly driven by security concerns: tracking stolen items, worried parents keeping track of their teenagers, or warning of possible hazards. In-car navigation devices have been the quickest to catch on in the marketplace, and car manufacturers are looking to go one step further by offering automotive health monitoring systems to make costly warranty services unnecessary and to avoid unexpected breakdowns. Another commercial success, truck fleet management systems improve logistics by optimising truck allocation, minimising idle time, and tracking truck abuse. No doubt the trend will continue as many more devices are designed with built-in GPS receivers.

Map-based web applications dominate society's perception of LBS. An extensible architecture, combined with community driven content, has provided a fertile environment for rich, specialised applications. Often a Geographical Information System (GIS) is working behind the scenes.² For example, photos shot by a digital camera with GPS are automatically geotagged. This technique adds context to images, database records, or other artifacts. GPS co-ordinates are added to the picture file as metadata. With this contextual information, displaying the location where the photo was shot is possible. This is a truly value-added way to organise your photos.

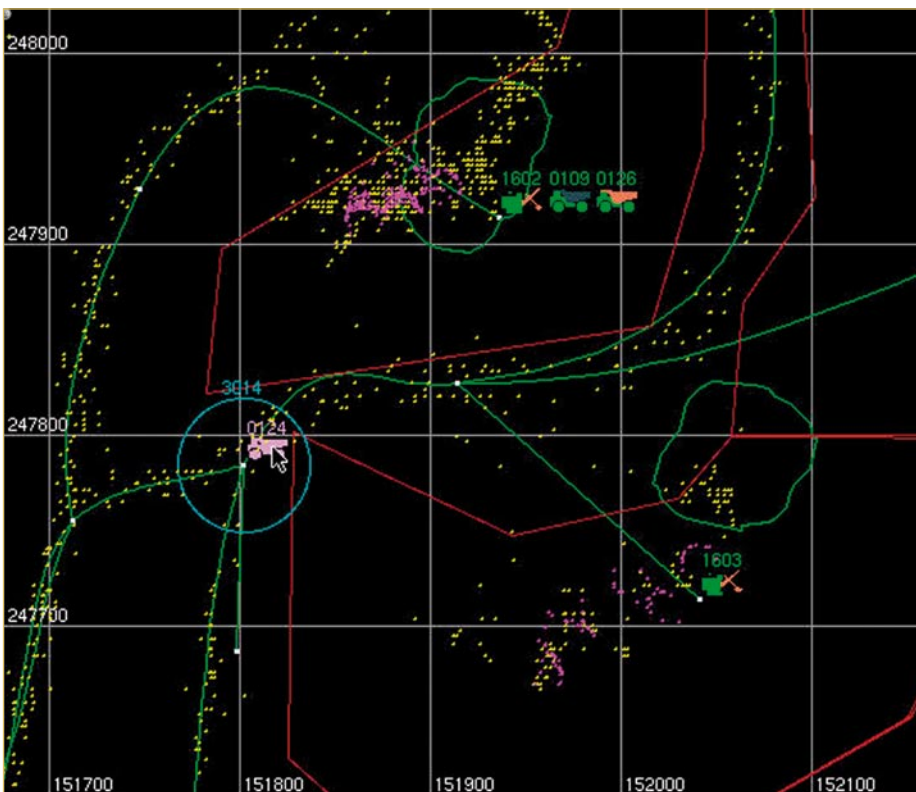
Location-based applications fall into the following categories:¹

- Navigation.
- Information.
- Tracking/management.
- Games.
- Emergency.
- Advertising.
- Billing.
- Leisure.

Many of those categories have logical counterparts in the mining industry. These will be examined in the remainder of this article.

Mining ahead of its time

Real-time fleet management systems were incorporated into the mining industry during the 1980s. Modular Mining



Mining trucks and shovels displayed in Modular Mining Systems' PitGraphics™ application.

Systems, Inc. was at the forefront of that technology offering products for both open-pit and underground operations. The first systems tracked equipment positions with radio beacons, which were later replaced by GPS in the mid-1990s. In both technologies, location data was mainly used to determine when equipment passed a waypoint. This information provided the basis for dynamic truck allocations, best path calculations, and optimisation algorithms such as those utilised in Modular's flagship product: the Dispatch® system. Optimised allocation of high capital-cost equipment has led to improvements of 10 - 15% in truck productivity. This has translated into annual savings in the millions of dollars for large-scale open-pit mines.

Another example of early technology adoption by the mining industry is seen in the use of centimetre-accurate Real-Time Kinematic (RTK) GPS for machine guidance systems. This technology uses GPS position data to send continuous navigation and guidance information to equipment operators, which increases productivity and allows quality execution of planned targets and tasks. Popular machine guidance applications in mining include excavators, dozers, and drills. When equipped with RTK GPS, shovels can perform selective digging and achieve finer elevation control. Dozers and graders can confidently work towards, or maintain, the target design surface. Drills with these applications navigate to designated holes, calculate target hole depth on-the-fly, and give feedback on the drill pattern for use in the blast management process. Since the equipment knows its location, the right targets and tasks are delivered automatically. Complementing productivity with safety, the Modular ProVision® system applies RTK GPS technology to deliver a proximity warning product that does not require installation of additional hardware on the equipment.

Events have been geotagged in fleet management products such as the Modular Dispatch® system, for a long time. Specific examples include:

- Immobility events (idle time).
- Proximity events (getting too close to hazardous objects or other equipment).
- Travel speed along haul roads.
- Mobile equipment maintenance system events that sense and report changes in temperatures, pressures, voltages, fluid levels, etc.

- Operational data such as the origin and destination of each load.

In current practice, these events are simply displayed on a digital mine map and the system operator uses personal judgment to identify problems and deduce their root cause. In contrast, by using professional GIS applications mine staff can make informed decisions based on quantified data, rather than human intuition.

Will mining reclaim the lead?

Historically, most fleet management and mine planning suppliers implemented their own proprietary solutions to address the relationship problem between geographical and attribute data. The advances in GIS techniques that became popular in the early 1990s were never adopted. Many of the problems that had been solved in isolation, could have benefited by borrowing solutions from the GIS body of knowledge. GIS consists of many well-delimited parts that handle different aspects of the process:

- Data acquisition/import from different sources.
- Data processing to create a consistent data model.
- Spatial analysis of data to extract information.
- Presentation of data, e.g. interactive maps.

Technology improvements mean that data acquisition will be more sophisticated in mining as well. Virtually everything and everyone can now be tracked and geotagged. This year, Modular will launch a low-cost position tracking solution for both light vehicles and heavy mining equipment. This product will monitor restricted areas as well as proximity to hazards and other mining equipment. Taking this a step further, this new product will also geotag events such as speeding, rough roads, and OEM interface alarm conditions monitored by the MineCare® system.

This leads us directly to the most powerful concept within GIS: spatial analysis. Spatial analysis applies the following techniques:

- Utilities - models data for map representations, e.g. contour maps.
- Geostatistics - considers the spatial distribution of data.
- Geocoding - approximates location from a database description, or infers description based on location (the

same technology used by websites to determine the location of users).

- Topological modelling - analyses the influence of topology on operational results.
- Network modelling - simulates transport scenarios in the event of changing conditions such as: widening or narrowing roads, added destinations, etc.

The end goal is to provide maps and tables that consolidate all the aforementioned operations. Web-based map delivery is already widely accepted and considered crucial in the dynamic environment of an open-pit mine.

As in the non-mining world, where communities help to update web-based databases, employees, contractors, or even mine visitors will be able to generate 'content' (information), given the right tools. Examples could include accidents, emergencies, road blocks, or even operational observations.

The next generation of Modular products will employ open standard techniques and technologies as recommended by Open Geospatial Consortium®.³ This leverages existing solutions and helps pave the way for even further integration and innovation.

Conclusions

If time is money, then position tracking is a potential gold mine. Knowing where something happened, in conjunction with who was driving, where they were going, and who was in the vicinity, provides a powerful data combination for insightful analysis, informed decision-making and safer operation.

Recording this information in an accessible data format is only half the battle. Delivering information in context, in real-time, and to the right decision makers will define successful LBS for mines globally. The mining industry pioneered the use of location tracking for profit and safety. The next generation of LBS, applied in mining, will provide many new opportunities in the years to come. ■

References

1. Kanagalingam, A., 4QH3 Panel Discussion-Mobile Business Issues: Location Based Services, 12 Mar 2007. http://www.tamil-listing.com/presentations/Mobile_Business_Issues_Panel_Discussion.ppt#256,1,Mobile_Business_Issues:_Location_Based_Services.
2. "GIS" Wikipedia. http://en.wikipedia.org/wiki/Geographic_information_system.
3. OGC <http://www.opengeospatial.org/>.