Nicole Lyman, Dyno Nobel, USA, outlines a form of technology that can help mines reduce the time taken to initiate a blast in drill and blast development mining, whilst ensuring the safety of its workforce.

An underground mine that had been employing conventional methods for the initiation of multiple blasts found the end of shift firing requirements to be time-consuming and inefficient. There were also concerns about employee safety when blasts had to be fired from underground. To address these issues, the mine was seeking a reliable remote initiation system that would ensure the safety of its workforce by having the underground workings clear of personnel prior to firing.

After speaking with Dyno Nobel, the mine decided to implement BlastWeb™, a centralised blasting system that is specifically designed for use in underground mining operations.

BlastWeb allows reliable remote initiation of development and production blasting from a safe and controlled location underground or on the surface. The blast areas can be completely evacuated as no one is required to be underground for the blasting.

This networking system can communicate on multiple platforms, such as WiFi, ethernet, copper, fibre and leaky feeder, which can be easily adjusted to the mine's needs. The heart of the system is the Blast Control Unit (BCU), which can be permanently installed in the mine at a safe distance from the blast. This control unit communicates with a surface blast controller that sends the blast signal and the terminator, which communicate firing readiness of the detonators and protects the BCU during the blast. This system can initiate both electronic detonators and NONEL® detonators (using DriftShot Starter) so the mine could use the detonators it already had on hand.

In addition to the obvious safety benefits and its communication capabilities, the other main benefit of the system is a reduction in the blast misfire rates.

The mine is developing multiple ore bodies over a vast area and across multiple levels. Blasts are initiated at the end of shift with multiple development headings and production blasts fired across various levels and areas of the mine. With a multitude of personnel working over this vast area, blast clearances can be difficult and time-consuming. To combat this, a radio-based, remote blasting system was introduced some years ago to eliminate risks involved with initiating blasts from an underground firing location. The change ensured the mine was able to only initiate blasts once the tag board was completely cleared and no personnel were left inside the blast zones.

The old system was reliable, but without two-way communication, positive confirmation of initiation was impossible, particularly if

multiple headings were initiated simultaneously. Poor radio frequency (RF) communication led to numerous misfired headings that consequently resulted in costly production delays. There were also areas without radio-based remote blasting system RF reception that still had to be fired from underground using conventional methods, leaving personnel exposed to blasting activities.

There were two main project goals:

- The ability to fire all blasts from a central location with the whole underground complex cleared of personnel.
- Minimise the rate of misfired blasts.

The basis of the BlastWeb system is to enable firing of all underground blasts from a safe, central location, nominally on the surface. The system supports easy initiation of NONEL detonators to fire development headings, as well as initiating electronic detonators that are used in more complex production blasts.

To guarantee robust communication, ethernet was chosen as the primary communication medium, rather than conventional modems or the RF leaky feeder. To ensure a robust installation, the blast equipment was permanently installed, powered directly from the mains with battery backup capability. The utilisation of permanently installed equipment eliminated blast delays as the nature of portable equipment makes them more susceptible to damage during transport or failures due to poorly maintained batteries. Primary fire lines were specified to withstand normal abuse in underground mining environment.

After the initial infrastructure planning phase, installation, commissioning and training was completed within a month. Each BCU had six channels that were terminated in different locations, allowing close access to firing line connection points in nearby working areas. Each channel had the ability to initiate 50 headings using electronic detonators. Centralised blasting operations were to be conducted from Mine Surface Control via PC-based software.

The installation of BlastWeb allows the reliable remote initiation of development and production blasting from a safe and controlled location. The communication platform allowed for the mine to know the detonators were connected and could be detonated once the blast command was provided, avoiding any misfires.

The system is easy to use with a shallow learning curve, which, in turn, supports blast crew acceptance. Within weeks, the blast crews were capable of operating the system without any supervision.

As BlastWeb continuously scans the installation, this allows operators in Mine Surface Control to progressively identify which areas are available for blasting end of shift. This transparency of when headings are connected assisted Mine Surface Control in assessing blasting schedules in real time.

In the six months prior to the implementation of BlastWeb, an analysis of the blasting data showed that out of 961 blasts, 52 headings were misfired – a 5.4% misfire rate. In the six months following the implementation of BlastWeb, out of 212 blasts fired with the system, there were no misfires. These headings were all fired as planned and on time from Mine Surface Control. The results speak for themselves.

Using centralised blasting equipment capable of reliably initiating both NONEL and electronic detonators has opened the door for continued blast optimisation work to further improve blasting practices and potentially improve mine production.

In addition to using BlastWeb for underground mining, Dyno Nobel has worked with other mines to offer benefits such as reducing overbreak and improving cycle efficiencies with the use of its other underground mining equipment and products: DYNOMINER® and TITAN® 7000 RU with the application of Dyno Nobel's electronic detonators.

A series of development optimisation trials were conducted at an underground silver, lead and zinc mine. The mine evaluated various elements of drilling and blast patterns in order to establish standards to optimise the development cycle. This included perimeter charging, drill and charge designs utilising bulk emulsion and the use of precision timing in both perimeter only and full-face development headings.

The trials were conducted in a controlled environment with each introduction element measured and validated against captured benchmark practices, the resulting benefits were:

- 12% savings in direct development costs.
- 13% reduction in the development cycle time.
- Increased productivity to the development schedule.
- Improved standard in drilling practices.

The optimal charge designs were achieved in practice using the DYNOMINER underground bulk delivery system, and the TITAN 7000 RU bulk emulsion. String loading capabilities were utilised to improve perimeter control, adjusting the density to suit ground conditions. Using the bulk emulsion also eliminated traditional manual handling issues associated with the use of specialised perimeter products.

The application of electronic detonators contributed to the success of the development optimisation process. The precision timing mitigated delay scatter while combining timing flexibility and accuracy resulting in consistent blasting outcomes.

In the end, the mine was able to improve safety by eliminating manual handling issues associated with cartridge products and allowing blasts to be initiated from a safe location. Overbreak was reduced from 25% to 5%, creating a smooth profile and reducing radial crack damage outside the perimeter. Reduced explosive usage per face by 30% – a decrease in cycle time of 13%, increasing development productivity – helps with the result of a 12% savings in direct development costs.

The ability to remain sustainable in the face of adversity and reap the benefits of improved margins in favourable markets is dependent on reducing the cost per metre of development. Establishing standards and optimising the various elements of drill and blast development mining will assist in ensuring the adoption of best practices and optimal cost positioning. GMR