Proximity Detection in Mining Environments
Whitepaper

September 2023

Introduction

Safety remains a major priority of the mining sector and the introduction of new technology is transforming the industry and helping to make mining safer and more sustainable. Globally, there is increasing appetite for the widespread introduction of technology to reduce mining vehicle-related accidents. By way of example, the International Council on Mining and Metals (ICMM), Innovation for Cleaner, Safer Vehicles (ICSV) initiative lists three main priorities, one of which is to '*make vehicle collision avoidance technology available to mining companies by 2025.*'

This whitepaper focuses on Cohda Wireless's vehicle connectivity technology and its potential to significantly enhance safety in the mining industry. While progress has been made to reduce the number fatalities in the mining sector, the industry's goal is to eliminate vehicle related fatalities entirely. As reported by ICMM members in 2022[1] the highest number of fatalities occurred with mobile equipment incidents with over 55% of these being in underground mines.

As we explore the realm of proximity detection in mining, this white paper delves into the fusion of technology and responsibility. It envisions safer mines where innovation aligns with the commitment to preserving lives, fundamentally reshaping mining's safety landscape.

[1] https://www.icmm.com/website/publications/pdfs/health-and-safety/2023/benchmarking-safety-data-2022.pdf

2 The case for an industry-wide solution

From a safety perspective, mining operations are focused on preventing accidents in which mining vehicles collide with each other or with mining personnel. Given the nature of underground mining environments where large, powerful vehicles are in operation, usually in very close proximity to mine personnel, the potential for injury and death is substantial and incidents are relatively common, as confirmed in the ICMM 2022 Safety Performance Report[2]. The same is true for above-ground or open-pit mining operations in that the road transport environment is invariably busy and restricted as compared to the advanced infrastructure of the streets and highways in towns and cities.

Typically, most mining environments will host a variety of independent technology solutions introduced to prevent collisions between vehicles and people such as cameras, radar, lidar, and ultra-wide-band technology. These technologies, though useful in many respects, are ultimately limited in their efficacy as they rely mainly on 'line-of-sight' connectivity. They are limited, for example, in their ability to prevent accidents when there is mine infrastructure between two vehicles that are on a collision course or where there is a mine worker about to unwittingly walk into the path of a mining vehicle from around a blind corner.

Applying these technologies, the vehicle operator and/or the mine worker is invariably alerted to impending danger too close to, or at the very point of impact, when it may be too late to take action.

A further complication of collision avoidance symptoms that rely on GNSS (satellite navigation) is that vehicle positioning accuracy can be extremely unreliable, or non-existent, in underground or open pit remote mining environments with compromised ground to satellite connectivity.

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[2] icmm.com/website/publications/pdfs/health-and-safety/2023/benchmarking-safety-data-2022.pdf

3. Cohda Mining Locate – Proximity Detection System – borne out of Cohda's world-leading V2X technology.

The technology behind Cohda's Proximity Detection solution was developed to connect vehicles to each other and to roadside infrastructure to form a cooperative intelligent transport system.

Cohda's V2X solutions are applied in more than 60% of connected vehicle trials in the world and feature in the first two V2X production vehicle platforms, in readiness for an impending connected road transport system.

4. Cohda Mining Locate - Proximity Detection System - how does it work?

In the V2X (Vehicle-To-Everything) systems associated with the cooperative intelligent transport vehicles communicate with other devices (vehicles, infrastructure, pedestrians, etc) using wireless communication systems such as Dedicated Short Range Communication (DSRC) with IEEE 802.11p as the underlying physical and medium access layer technology.

The Cohda Wireless Locate Proximity Detection System employs peer-to-peer communication - V2V (Figure 1) & V2P (Figure).
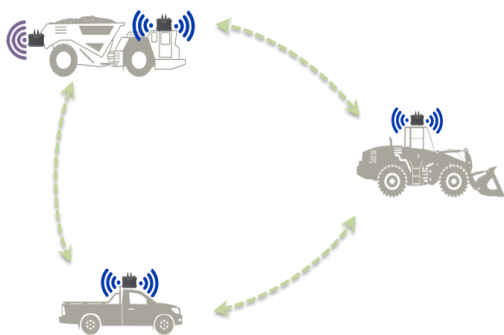

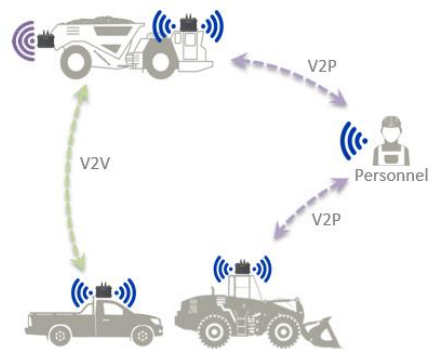
Figure 1: V2V Peer to Peer   Figure 2: V2P Peer to Peer

The technology integrated with a Tier 1/ Fleet Management provider works as follows:

- Heavy mining vehicles are fitted with an XBU-V unit in the front and rear parts of the vehicle so that the vehicle can be detected, and range to other devices. For light vehicles one XBU-V unit is installed. Mine personnel carry a similar but smaller device in their cap lamps that communicates their distance relative to other devices several times per second.   The system can accommodate hundreds of signals. Cohda Locate technology is built into the tags which are available through a 3rd party to cap lamp manufacturers.
- The XBU-V's on vehicles use Time-of-Flight analysis of wireless signals to resolve spatial locations.   The XBU-V measures the distance between the vehicle and other vehicles, as well as personnel, many times per second and sends information to an operator display in the vehicle for driver notification.
Zoning configuration is per direction of the Mine Operator as shown in Figure
- XBU-V then feeds the ranging information to an HMI in the vehicle for driver notification
- The closer the mining vehicle is to another vehicle or to mine personnel, the greater the intensity of the warning received by the vehicle operator enabling him/her to proactively avoid safety risks (V2V and V2P).
- The system can register devices so as to provide factual information to the vehicle operator, for example, it can list the name of the mine worker that is in close proximity to the vehicle, rather than just present a random identification number.
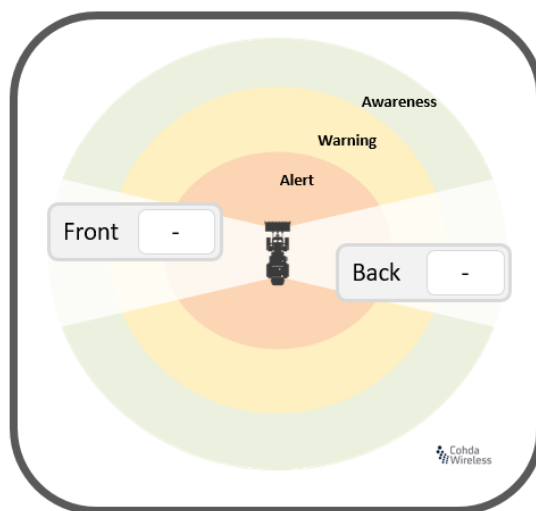

Figure 3: Cohda Locate Safety Zone Configuration

5.   The safety and operational benefits

The Cohda Mining Locate system is unique on account of its unrivalled effectiveness and rugged usability in the most challenging of underground mining environments.   Key benefits include:

- Cohda Locate enables superior awareness and reaction for the proactive avoidance of accidents.
- Enables advanced collision avoidance and personnel safety applications to be deployed
- Currently supports EMESRT** Level 7 (Alert) + partial Level 8 (Advise) controls
- Full Level 8 controls and Level 9 (Intervention) controls on product roadmap
- Integrated with HMI on vehicles to provide alerts to personnel
- Designed for easy integration with fleet management solutions
- Supports fusion/switch-over between Cohda Locate and GNSS ranging and location

As per Figure 4, the primary advantage of Cohda's Proximity Detection System is that by using V2X technology, the system can 'see around corners' as opposed to relying on the 'line-of-sight' connectivity limitations of sensors, lidar and radar.

In this instance, a mine vehicle and mine worker are on a potential collision course, and even though the driver of the vehicle cannot see the worker, the driver will be alerted to the approaching worker so that an accident can be averted.
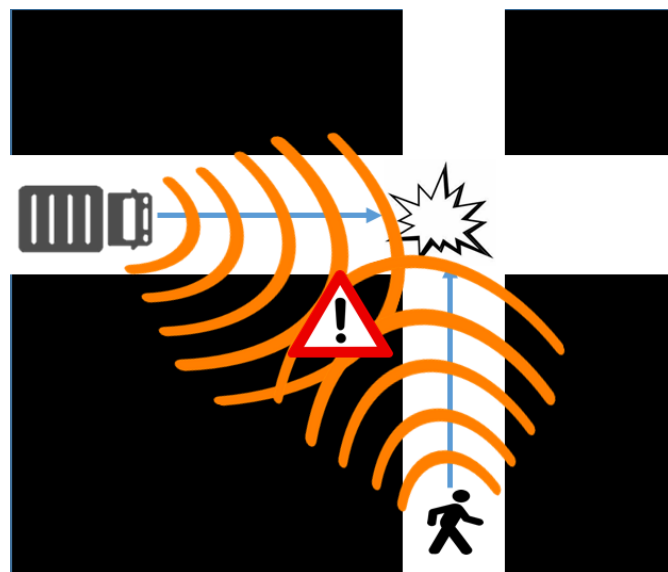

Figure 4: Illustration demonstrating value of non-line-of-sight awareness

Example results with situation as per Figure 5:

- V2V – A vehicle Remote Object (RO) is detected 100m away (around corner) from the Local Object (LO) travelling at 25km/hr.
  If the RO is stationary the LO has 14 seconds to react and take corrective action to avoid a collision with the RO.
  If the RO is also travelling at approximately 25km/hr the LO has 8.5 seconds before a potential collision.

- V2P – A Miner (RO) is detected 60m away (around corner) from the LO travelling at 25km/hr.
  With the RO at walking pace or standing still, the LO has approximately 8 seconds to reach and take corrective action to avoid hitting the Miner RO

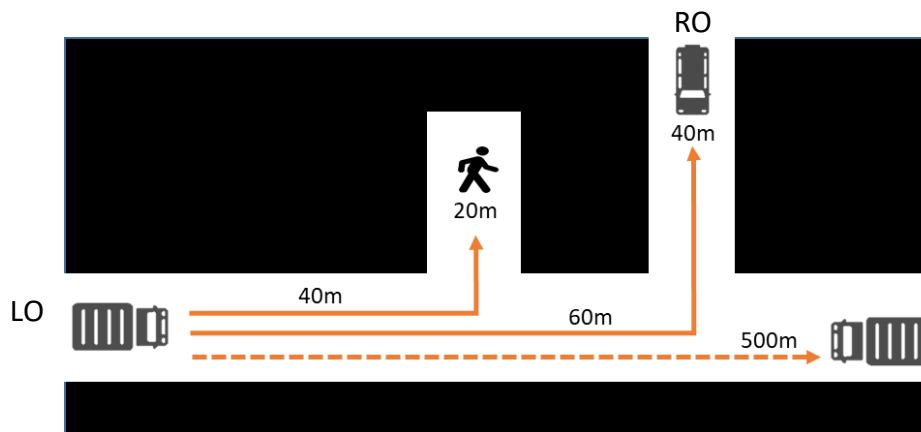- In all of these scenarios to have this advanced warning is incredibly important.

Figure 5: Example results of ranging performance

6. System implementation and integration

Cohda works with mine suppliers and fleet operators to develop and implement safety protocols that can include daily hardware health checks. Cohda can offer customers a Day One Integration service and full implementation support.

Cohda's solutions have been applied in more connected vehicle trials than any other company of its kind in the world and Cohda's team of engineers and researchers have extensive experience in trialling and implementing the Cohda proximity detection system in open pit and underground mining environments.

7. Conclusion

In summary, Cohda's Proximity Detection Solution can help prevent collisions and other accidents in underground mining environments by providing real-time alerts and warnings when workers or equipment are in close proximity to each other, regardless of the physical infrastructure involved. This can help reduce the number of injuries and fatalities in the mining industry.

In addition safer operations also provide the benefits of:

- **Increased efficiency** – Cohda's Proximity detection systems can help reduce delays in the mine caused by accidents.
- **Reduced costs** – Cohda's Proximity Detection system can help reduce costs associated with accidents and equipment damage in the mine. By preventing collisions and other accidents, these systems can help reduce the need for repairs and maintenance and reduce downtime in the mine.
- **Compliance** - Many mining operations are subject to regulations that require the use of proximity detection systems in certain situations, such as when operating large equipment or in areas where workers are present. The implementation of Cohda Mining Locate Proximity Detection technology can help ensure compliance with regulations.

For more information please contact Cohda Wireless at inquiry@cohdawireless.com