
TORSA
Building smarter and safer mines through IoT technology

TORSA

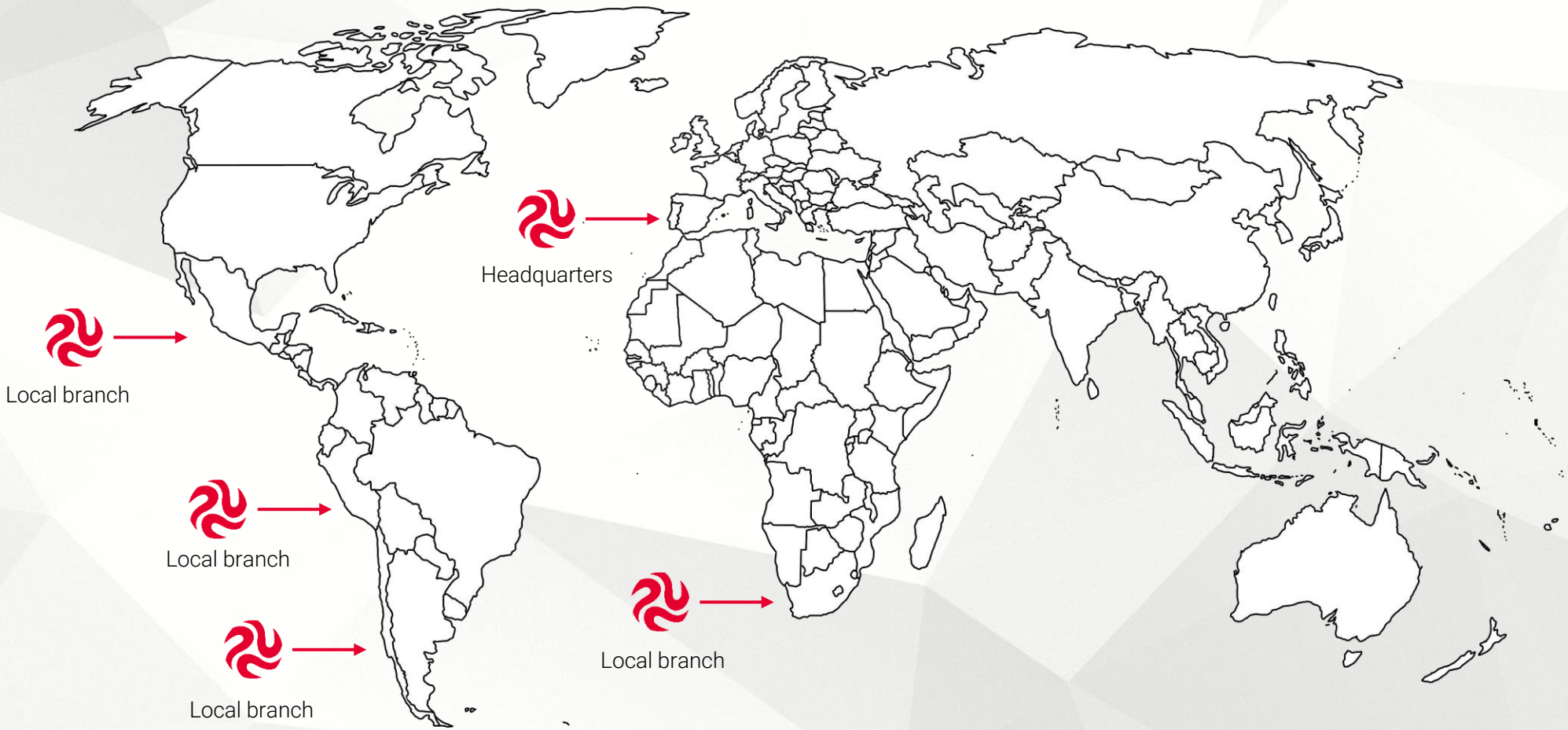
TORSA is a business group headquartered in Malaga (Spain). The group has activity in various industrial sectors such as **renewable energy, logistics and heavy industry.**

The main activity of TORSA's engineering division is **the design and manufacturing of high-level technological solutions** for the industry. We develop own products and work closely with our clients to develop customized solutions.

One of the main fields in which TORSA's developments are focused is mining, with a wide range of **products aimed at meeting technical needs and solving common problems throughout the industry.**

In Peru, TORSA has been collaborating closely for more than 6 years with **Compañía Minera Antamina,** currently having equipment installed in its fleet with thousands of hours of uninterrupted operation. Antapaccay (Glencore) and MarCobre are customers in Peru as well. We also serve customers in Chile and Mexico.

TORSA WORLDWIDE



SOLUTIONS FOR THE MINING INDUSTRY

TECHNOLOGY AS A TOOL OF IMPROVEMENT

SAFETY

- COLLISION AVOIDANCE FOR SHOVELS
- COLLISION AVOIDANCE FOR HAUL TRUCKS AND LIGHT VEHICLES
- COLLISION AVOIDANCE FOR DRILLERS
- COLLISION AVOIDANCE FOR UNDERGROUND

OCCUPATIONAL HEALTH

- HUMAN VIBRATION EXPOSURE MONITORING
- TEMPERATURE AND HUMIDITY MONITORING

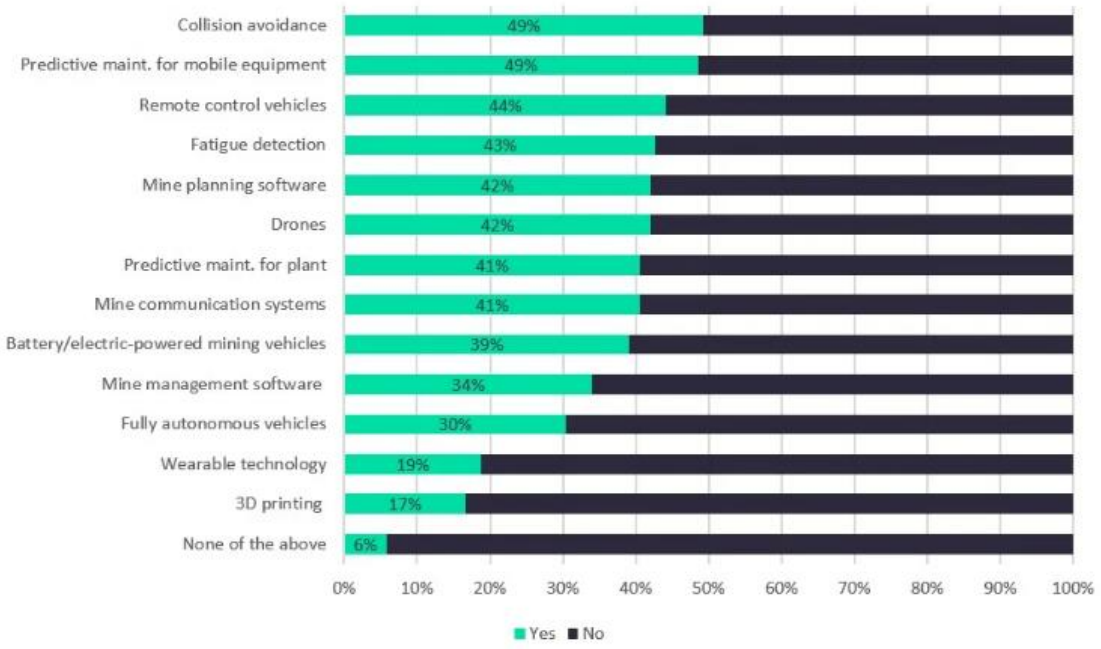
PRODUCTIVITY

- OPTIMIZATION OF THE APPROACHING AND LOAD OPERATION GUIDED SPOTTING
- FLEET PRODUCTIVITY MANAGEMENT

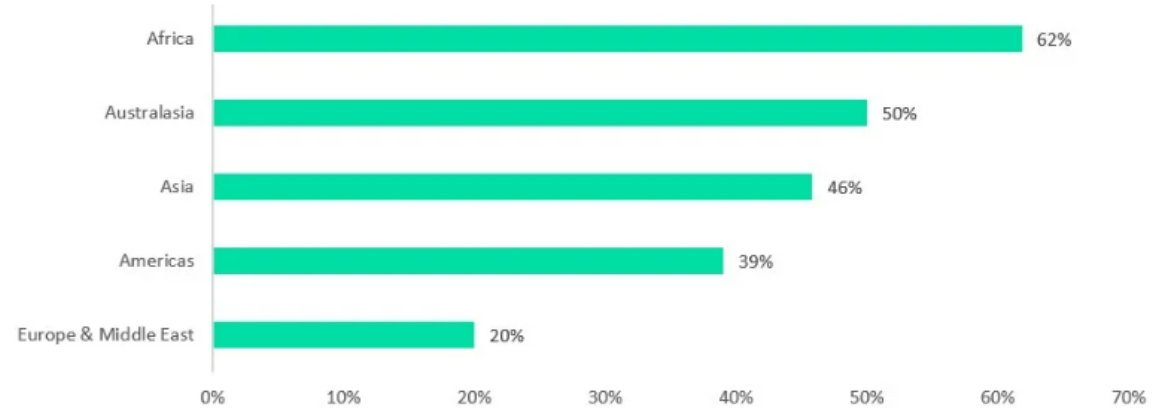
All the solutions developed by TORSA centralize their data on a single platform in order to provide relevant information to the different areas of the mining operation. In this way, it is intended to cover the gap between the operational personnel in the field and the “decision makers” of the mining operation.

COLLISION AVOIDANCE MARKET OPPORTUNITIES

Proximity detection systems (PDS) and collision avoidance systems (CAS) market is predicted to grow exponentially in the next decade. Recent studies and articles show PDS technologies will be where mines will focus efforts and investments in the coming years. In a region-by-region comparison, data show Africa will be the region where mines will dedicate more resources to PDS and CAS.



Source: Global Mine-Site Technology Adoption Survey, 2022



Source: Global Mine-Site Technology Adoption Survey, 2022

South Africa´s Department of Mineral Resources and Energy (DMRE) is promoting deployment and installation of CAS and PDS in every South African mine by the end of 2023

INTERNATIONAL REGULATION COMPLIANCE

TORSA collaborates with the International Council on Mining & Metals (ICMM) where the company is taking part of the **Innovation for Cleaner Safer Vehicles (ICSV) program** which brings together 27 of the world's leading mining companies and some of the best-known truck and mining equipment suppliers to collaborate in a non-competitive space to accelerate the development of a new generation of mining vehicles and a new safety standard.

In addition, **TORSA belongs to the working groups of the EMESRT** (Earth Moving Equipment Safety Round Table), where they are **defining** in collaboration with the entire international community all the **safety requirements** that all mining operations must meet about safety in terms of the interaction of vehicles and **functionalities** of the **collision avoidance systems** (CAS).

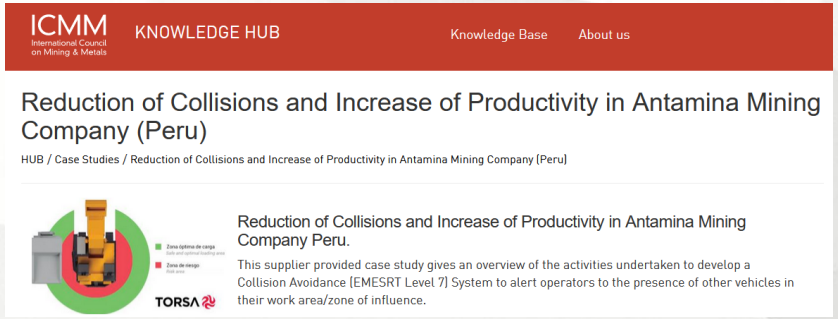
ICMM International Council on Mining & Metals

EMESRT Earth Moving Equipment Safety Round Table

Innovation for cleaner safer vehicles (ICSV)

Alcoa · AngloAmerican · BHP · Glencore · Rio Tinto · Teck · Barrick · TORSA · Vale · MMG · Freeport-McMoRan · Newmont · Caterpillar · Komatsu · Codelco

TORSA High Precision Collision Avoidance System for Shovels deployment in **Antamina** attracted the attention of the international mining community due to the technological innovation that it has brought about and the centimeter precision which it detects objects in its area of operation.



INTERNATIONAL AWARDS

INTERNATIONAL AWARD OF HSE GOOD PRACTICES IN MINING 2021 (WOLDWIDE)

ISEM
INSTITUTO DE SEGURIDAD MINERA

System:
Human Vibration Exposure Monitoring

Award:
International winner of good practices in risk management and prevention due to the drastic reduction of cervical injuries in the mining industry.

TECHNOLOGICAL INNOVATION NATIONAL AWARD 2019 (PERU)

Sociedad Nacional de
MINERIA PETROLEO
Y ENERGIA

System:
High Precision Collision Avoidance

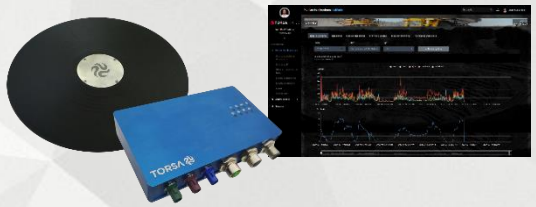
Award:
Drastic reduction of events between vehicles, increased safety in loading tasks and the increase in productivity experienced.

PEOPLE'S CHOICE AWARD MERIT AWARD 2020 (INTERNACIONAL)

BHP

System:
Human Vibration Exposure Monitoring

Award:
Reduction of more than a 80% of cervical injuries reported, maintenance of lanes optimization and increase of productivity due to an increase of the life of the tires.



EVOLUTION AWARD 2020 (SPAIN)

BBVA

System:
Complete portfolio of solutions for mining industry

Award:
Excellence in the application of technology in the mining industry solving problems and increasing safety and productivity.


COLLISION AVOIDANCE SYSTEM
TORSA

3D COLLISION AVOIDANCE SYSTEM FOR SHOVELS

TORSA 3D Collision Avoidance System for Shovels is a **high-precision proximity alert system** that analyzes with a centimeter-level precision, the **interaction** between **vehicles** and the **shovel** and the shovel and the **mining front**, guaranteeing safety during loading and approaching operations.

The target of the system is to inform the operator of the machinery about the type, position, inclination and distance of the different vehicles and obstacles around him.

The system defines three risk areas:

- Green zone: optimal zone for operation (loading or cleaning).
- Red zone: high collision risk.
- Grey zone: remote zone for operation (loading or cleaning).

Shovel display

TORSA 3D collision avoidance system is the **only one** in the market able to reliably **detect** the **mining front**

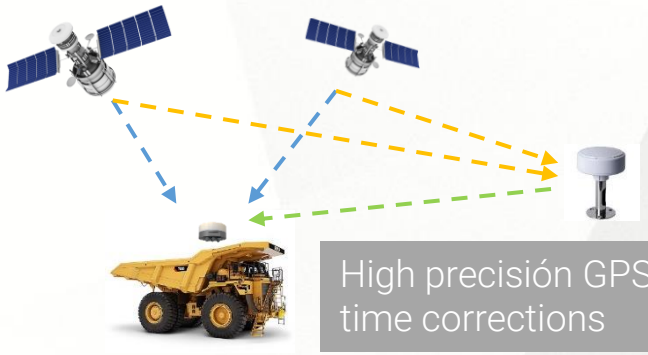
INTEGRATED TECHNOLOGIES

- LIDAR 3D (centimetric precision)
- High precisión GPS (RTK)
- Time of Flight (TOF)
- Radiofrequency (V2V)
- Network communications

COLLISION AVOIDANCE SYSTEM FOR TRUCKS AND AUX

TORSA 3D Collision Avoidance System for Haul trucks, Auxiliary and Light Vehicles is a proximity alert system with centimetric precision that predicts risk situations and alert the operator and is able to even **interact with the equipment (CONTROL LEVEL 9 - INTERVENTION)** if required.

Thanks to its integrated predictive algorithm, haul trucks are equipped with "senses", **being able to act differently depending on the type of situation the vehicle is.**



High precisión GPS with real-time corrections

System measures inclination, altitude and speed

INTEGRATED TECHNOLOGIES

- LIDAR 3D (centimetric precision)
- High precisión GPS (RTK)
- Time of Flight (TOF)
- Radiofrequency (V2V)
- Network communications

3D COLLISION AVOIDANCE SYSTEM FOR DRILLERS

In order to cover all vehicular interaction and protect all existing vehicles in open pit mining operations, TORSA has developed a **3D High Precision Collision Avoidance System for Drillers.**

The system has been designed to **identify any object (mining equipment, rocks, personnel, etc.) that could cause a hazardous situation in the driller's operating area.**

In addition, the system has a powerful communications interface that **allows to monitor its safety remotely while operating the rig remotely and autonomously.**

INTEGRATED TECHNOLOGIES

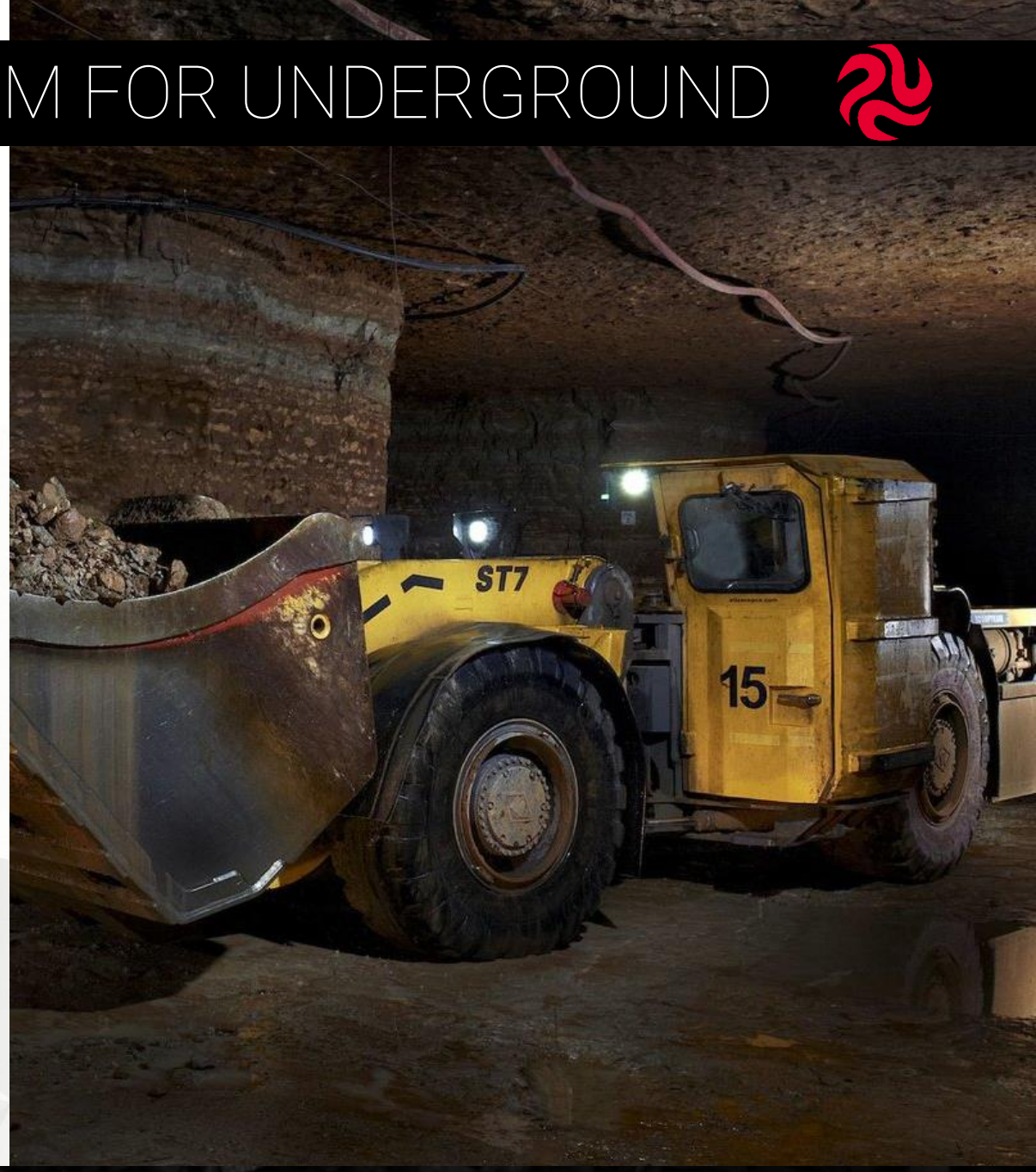
- LIDAR 3D (centimetric precision)
- High precisión GPS (RTK)
- Time of Flight (TOF)
- Radiofrequency (V2V)
- Network communications

3D COLLISION AVOIDANCE SYSTEM FOR UNDERGROUND

TORSA 3D High Precision CAS for underground operations covers the entire typology of equipment in the underground mining operation (scoops, trucks, etc.) and involved personnel.

Thanks to the implementation of different technologies and its predictive algorithm, the system is capable of **analyzing interactions between vehicles and people to avoid collisions and run overs.**

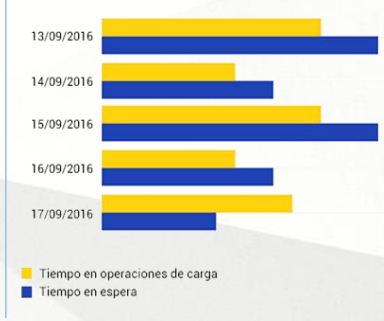
The system is able of alerting the machinery operator about the type, position and distance of the different vehicles, obstacles and people around.



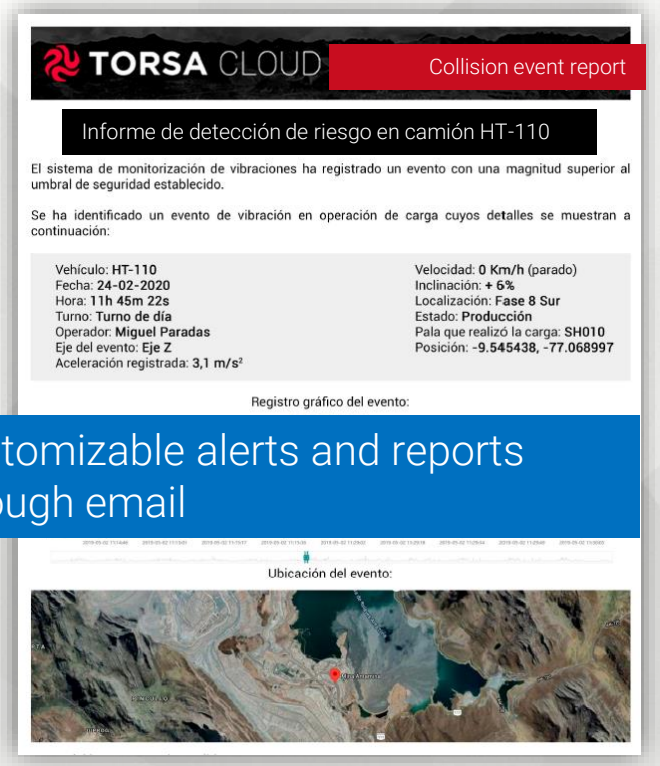
TORSA CLOUD SOFTWARE PLATFORM

All systems developed by TORSA are designed with network communications adaptable to the mine network to **centralize all data in a single data management platform called TORSA Cloud**.

This platform is **fully customizable for clients and can be hosted on either a client's local server or a TORSA cloud server**, and its objective is to provide relevant information to the different areas of the mining operation.



TORSA Cloud performs an information management based on profiles, **providing each user or group of users with the information necessary for the performance of their functions and decision-making.**



Customizable alerts and reports through email

HUMAN EXPOSURE VIBRATION MONITORING SYSTEM

HUMAN EXPOSURE VIBRATION MONITOR SYSTEM

Vehicle operators in the mining operation are exposed to many occupational agents that can pose a threat to their health and ergonomics during their driving activities: **noise, dust, vibrations, diesel particles,** etc. Those occupation agents may cause accidents or illness.

In recent studies by the University of Oxford (United Kingdom) and the University of Queensland (Australia) conclude that human exposure to vibration is the most invasive occupational agent posing the greatest risk to the mining equipement operators, and it may lead to chronic cervical injuries. International standards ISO 8041 and ISO 2631-1 regulate the human exposure to vibration thresholds.

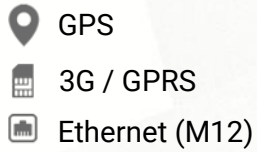
TORSA human exposure to vibrations monitoring system measures and evaluates vibrations mining equipment operators are exposed to. Vibration monitoring system measurements can be used as a prevention tool, helping reduce injuries occurred as a result of long exposure to high levels of vibrations.

HUMAN EXPOSURE VIBRATION MONITOR SYSTEM

Vibration exposure data is **collected by a sensor pad located in the operator's seat**.

This information is sent in real time to the communications gateway and from there to a server where the information is centralized for viewing through the TORSA Cloud platform thus ensuring the correct interaction, operation and technical information management for all our clients.

CAN Bus
Vehicle telemetry data source



GPS
3G / GPRS
Ethernet (M12)

01 Sensing element

Installed inside the operators´s seat. Sensing element will measure vibration in the three axis.

02 Gateway

Embarked device to receive and store all the information related to vibrations, telemetry and GPS location. Gateway will send the information to the server.

03 Server

Store and manage the information received from the Gateway. Information will be accesible using TORSA Cloud.

04 TORSA Cloud

Web platform to access fleet information located in the server.

In addition, **the sensor pad also records on its internal memory all the data related to vibrations and the timestamp (date and time) associated with the events logged.**

Compliance with international regulations and the allocation of a unique compliance certification document for each system manufactured, ensures this data is considered complete and valid by any type of audit or legal procedure.

BENEFITS AND PRODUCTIVITY INCREASE

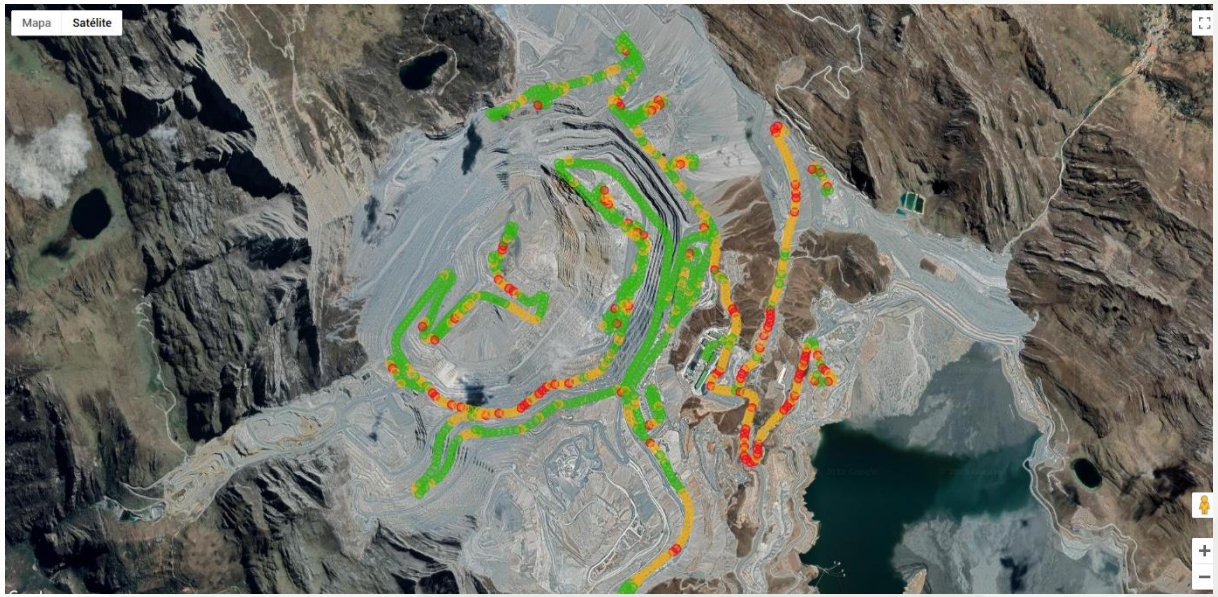
After the development and implementation of TORSA's fleet productivity and vibration monitoring system in the mining operation's fleet of vehicles, the following benefits have been observed in the different mining areas:

LOADING OPERATIONS ANALYSIS

- By monitoring the vibrations in real time and continuously, it is possible to analyze the serious injuries or "lashes" reported, which in turn enables the identification of those workers who need preventive training.

ANALYSIS OF THE MINE TRACKS STATUS

- Applying vibration fusion algorithms with the coordinates of the integrated GPS, hot maps of the mining operation are generated with the real-time status of the tracks as a tool to be used by the maintenance department.



- GPS tracks with soft vibrations recorded
- GPS tracks with medium vibrations recorded
- GPS tracks with critical vibrations recorded

TEMPERATURE AND HUMIDITY CONTROL

BOREA

Borea has been designed by TORSA to **continuously record and monitor all kind of physical magnitudes,** for example, temperature and humidity both in fixed locations and in mobile equipment (distribution vehicles).

The objective of Borea is to be able to control the temperature and humidity curves of the goods and to be able to **immediately identify** when they are out of the established safety ranges.

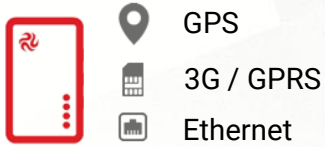
The system serves as a **traceability tool for the product's cold chain during storage and transport** complying with the guidelines and recommendations established by current regulations.

HOW IT WORKS

BOREA is made up of a **communications gateway and a range of dataloggers** that are installed at critical points in the warehouse or vehicle where continuous monitoring is necessary.

Data recorded by the sensors and dataloggers are sent in real time to the communications gateway, which in turn sends them to a server where the information is centralized for viewing through BOREA website platform.

01 Datalogger
With a catalogue of temperature, humidity, open/close door sensors, etc. to connect



02 Gateway
Data reception from dataloggers and information transferring to server through network.
GPS technology included for vehicles fleet management.

03 Server
Cloud hosted server with real time data received from the gateway

04 Web platform
Management and real-time monitoring of all the sensors implemented. Alarms, reports and statistics generation.

Additionally, the dataloggers can store up to 4000 records in their internal memory, associating them with the corresponding date and time for later synchronization with the nearest switchboard.

WIRELESS DATALOGGERS

TECHNICAL FEATURES

- Configurable sampling frequency (1 minute by default)
- Wireless data transmission
- Internal data storage (up to 4000 records)
- Real time clock (RTC)
- Internal temperature and humidity sensor
- Range of models with the possibility of connecting various analog sensors

Within the different types of Borea dataloggers, you can find various models designed to meet any customer need.

BOREA dataloggers have been designed to connect both analog sensors (PT-100 probes, 4-20mA pressure sensors, etc.) and digital (humidity sensors, open door, etc.), allowing **a resolution of up to 0.01 to also facilitate the different calibration and verification processes**. Both the frequency of registration and issuance of the loggers are fully configurable.

The BOREA dataloggers **send the data recorded every minute (configurable by the user)** so that they are subsequently received by the gateway and transmitted to the server where the management platform is housed.

By emitting every minute and guaranteeing constant coverage with the gateway (without the need to host internal data), a **battery** durability of **5 years** is guaranteed.

DATALOGGERS AND SENSORS

Temperature datalogger
1 channel + open door sensor

- Data type: **analogical**
- Communication: **wireless**
- Channels: 1 + door
- Door sensor: Yes
- Data update: 1 minute
- Battery life: 8 years
- Data memory: 27.000
- Accuracy: 0,01
- Proteccion: IP55/IP67

Code: BR-PT1
Model: 1660015_1

Temperature datalogger
2 channel + open door sensor

- Data type: **analogical**
- Communication: **wireless**
- Channels: 2 + door
- Door sensor: Yes
- Data update: 1 minute
- Battery life: 8 years
- Data memory: 27.000
- Accuracy: 0,01
- Proteccion: IP55/IP67

Code: BR-PT2
Model: 1660015_2

Temperature and humidity datalogger
2 channel + open door sensor

- Data type: **digital**
- Communication: **wireless**
- Channels: 1 + door
- Door sensor: Yes
- Data update: 1 minute
- Battery life: 8 years
- Data memory: 27.000
- Accuracy: 0,01
- Proteccion: IP55/IP68

Code: BR-DG1
Model: 1660012

Temperature and humidity datalogger
autonomous datalogger + Check routes

- Data type: **digital**
- Communication: **wireless**
- Channels: 2
- Data update: 1 minute
- Battery life: 8 years
- Data memory: 27.000
- Accuracy: 0,01
- Proteccion: IP55/IP67

Code: BR-TH
Model: 1660010

Pressure datalogger
1 channel + open door sensor

- Data type: **analogical (4-20mA)**
- Comunicatión: **wireless**
- Channels: 1 + door
- Door sensor: Yes
- Data update: 1 minute
- Battery life : 24v power
- Data memory: 27.000
- Accuracy: 0,01
- Proteccion: IP55/IP67

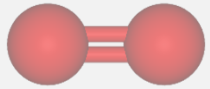
Code: BR-PR
Model: 1660017

T+H Sensor
Temperature + Humidity

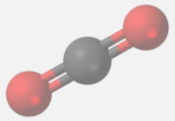
T+H Sensor
Open door detection

DATALOGGERS AND SENSORS BROCHURE

TORSA's BOREA brochure includes many **sensors with connection 4-20mA**:



Oxygen (O_2)



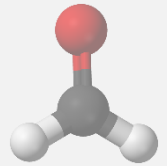
Carbon Dioxide (CO_2)

VOCs

Código: BR-4-20
Modelo: 1660017

4-20mA Dataloggers

- Data type: **digital**
- Communication: **wireless**
- Channels: **1**
- Data update: **1 minute**
- Power input: **VDC 6V-36V**
- Data memory: **27.000 values**
- Accuracy: **0,01**
- Protection: **IP55/IP67**



Formaldehyde

LUX

Sound dB

The system can be adapted to measure environmental variables values with any sensor with input 4-20mA.
This slide only shows some possibilities, but there are many more depending on customer requirements.

COMMUNICATIONS GATEWAY

TECHNICAL FEATURES

- Configurable network parameters
- Wireless data transmission and reception
- Internal data storage
- Ethernet and 3G / GPRS connectivity (data SIM slot)
- Real time clock (RTC)
- Optional internal GPS
- Wide coverage range

The communications gateway is the element in charge of **receiving data from the data loggers, as well as GPS positions** and transmitting them to the server for further processing.

Data are **associated with the time interval in which the recording occurs** and with the GPS coordinate in which the vehicle is at that moment.

The gateway, after collecting the data and storing it in its internal memory, broadcasts it over the network thanks to its communications **interface (Ethernet / 3G - GPRS).**

These data issued are eventually hosted on the associated server, on which the **platform that manages, analyzes and monitors** all the data collected in real time is installed.

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