The best of two worlds – Traffic Awareness and CAS

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Epiroc

Common reasons

Traffic incidents in underground mines

Poor Visibility

- The confined spaces, dust, and limited lighting in underground mines can make it difficult for drivers to see clearly. The lack of natural light combined with shadows can obscure hazards and other vehicles

Narrow and Confined Roadways

- The tunnels in underground mines can be quite narrow, making it difficult for vehicles to pass each other. There's also less room to maneuver, which can lead to collisions if drivers aren't careful

Equipment Failures

- Machinery used in underground mines, including vehicles, are subjected to harsh conditions. Failures can be related to brakes, lights, or other essential components that can lead to accidents if they're not regularly inspected and maintained

Common reasons

Traffic incidents in underground mines

Inadequate Training or Communication

- Operators might not be adequately trained for the specific conditions of underground mining. Lack of communication between drivers and other workers can also be a significant factor. For example, if a driver isn't informed about ongoing work or the presence of other vehicles in a particular tunnel, collisions can occur

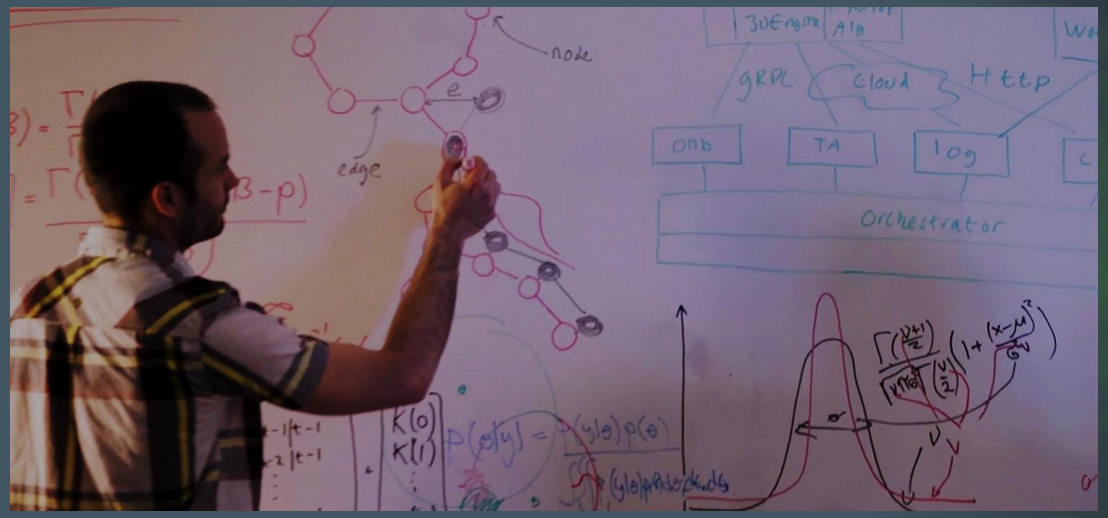
Road Conditions

- The underground environment can cause roadways to be slippery, uneven, or unstable. Water ingress, spilled materials, or ground movements can alter the conditions of the paths. Also, gradients and sharp bends can pose additional challenges for vehicle operations.

Epiroc Onboard - A unique solution

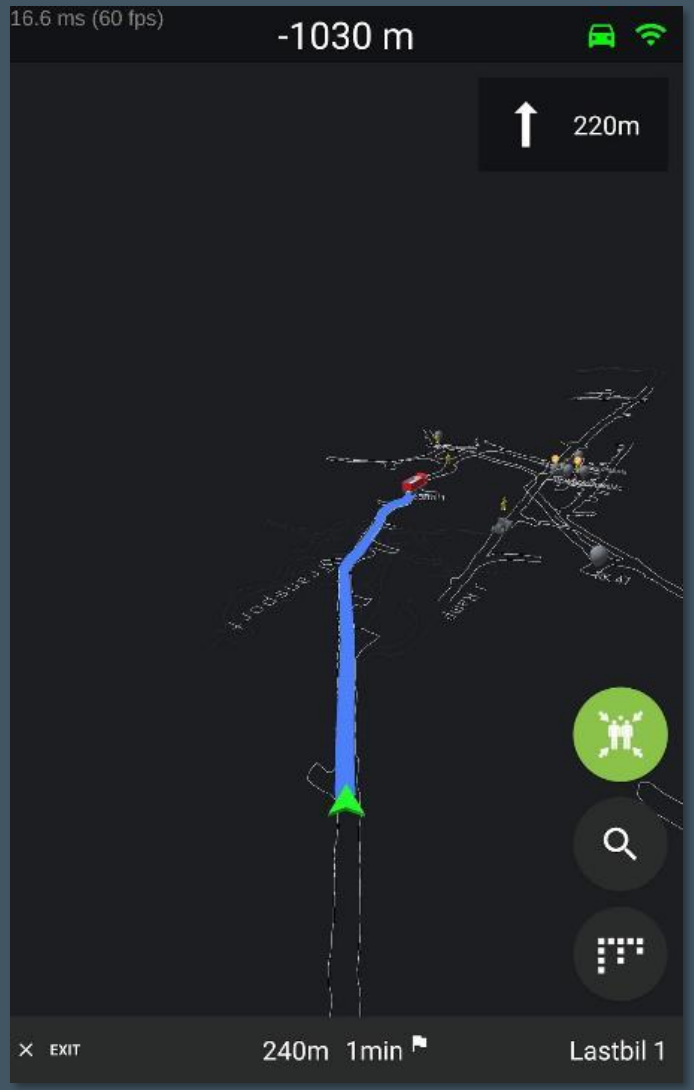
Self-sustained navigation using Epiroc's Hybrid Positioning

- In 2017, we invented an algorithm that allows a vehicle to position itself without any positioning or communication network
- The algorithm is totally self-sustained and delivers 5-10 meters accuracy **without** any dedicated positioning infrastructure



Helps you find the way

Navigation in Epiroc Onboard



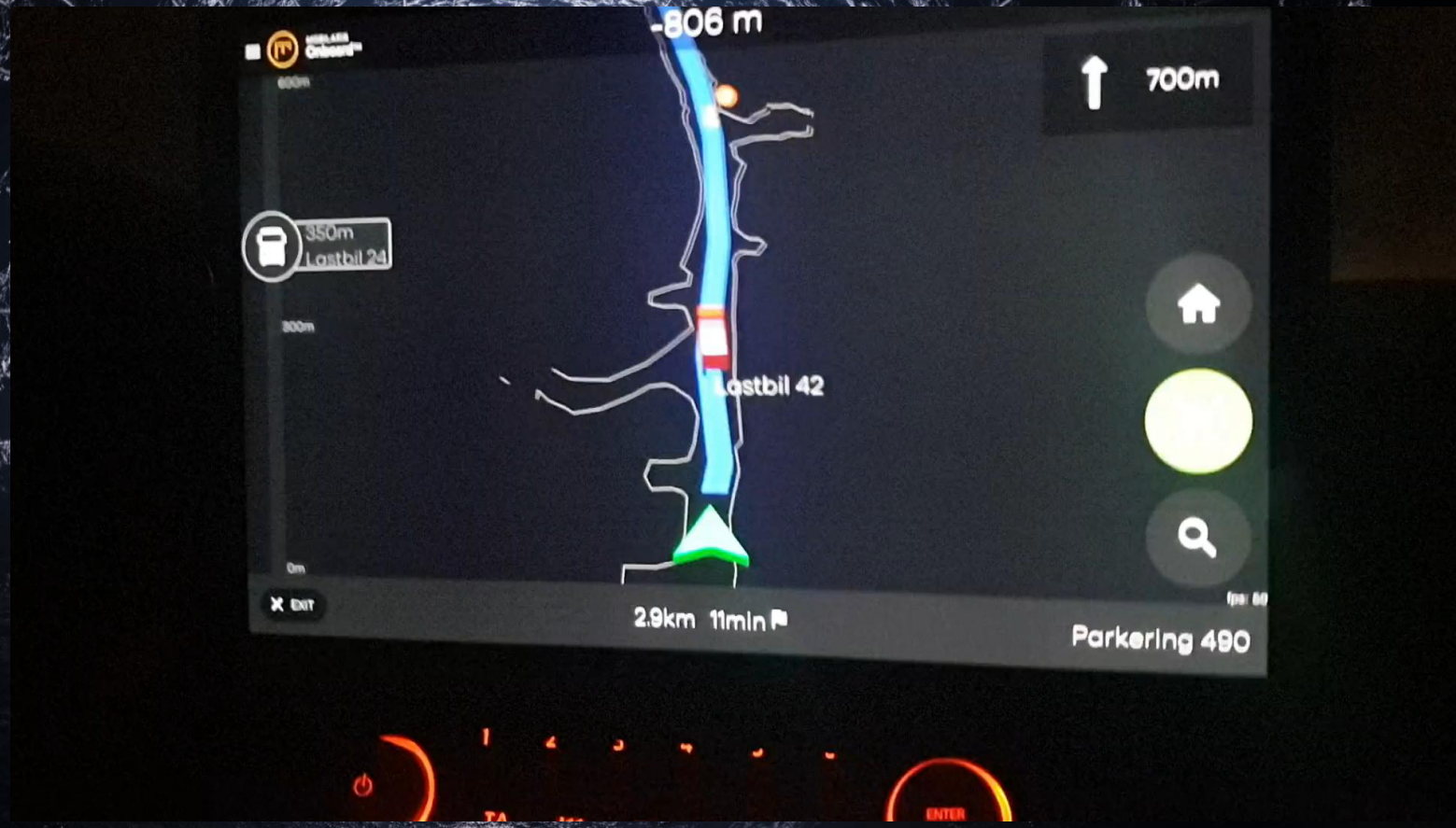
Without any need for an underground comms or positioning network, it acts just like a GPS enabled maps and navigation system

Helps you see through walls

Traffic Awareness in Epiroc Onboard

- Two vehicles, equipped with Epiroc Onboard, drives towards each other
- When the Backend Server detects a probable meeting, it triggers the Traffic Awareness bar in each vehicle a long time in advance (600 meters) so that the drivers can securely decide where to park
- One of the drivers parks safely. No stress!
- Early warnings, no collisions – increased safety
- No traffic disturbance – increased productivity

Note: Long-range early warnings on incoming traffic (need a comms network)



Results from mines using Epiroc Onboard

- Training time for new starters can be dramatically reduced as anyone is able to navigate in the mine. No need / less need training / shadowing etc
- Navigation can be achieved even in mines without any communication or positioning network (WiFi, LTE etc)
- Using Onboards navigation features reduces a lot of the wasted time, looking for things in underground mines
  - Equipment and machines
  - Fixed Assets
  - People
- Less braking, less reversing and more forward looking driving has proven to positively impact the traffic flow and cycle time with an increase in TKM of up to 5-6%
- Traffic incidents have dramatically been reduced as the increased awareness makes drivers take smarter decisions
- Reduced stress levels for drivers - better and safer working environment
- Reduces radio traffic

Epiroc Titan CAS

A strategic aquisition

- In 2022, Epiroc aquired South-African Mernok Elektronik
- Epiroc is now a leading supplier of Collision avoidance systems for the mining industry covering
  - Agnostic for light and heavy vehicles
  - Rail bound equipment
  - Scraper winches

Titan CAS sensing technology overview

Combination of technologies for effective collision avoidance

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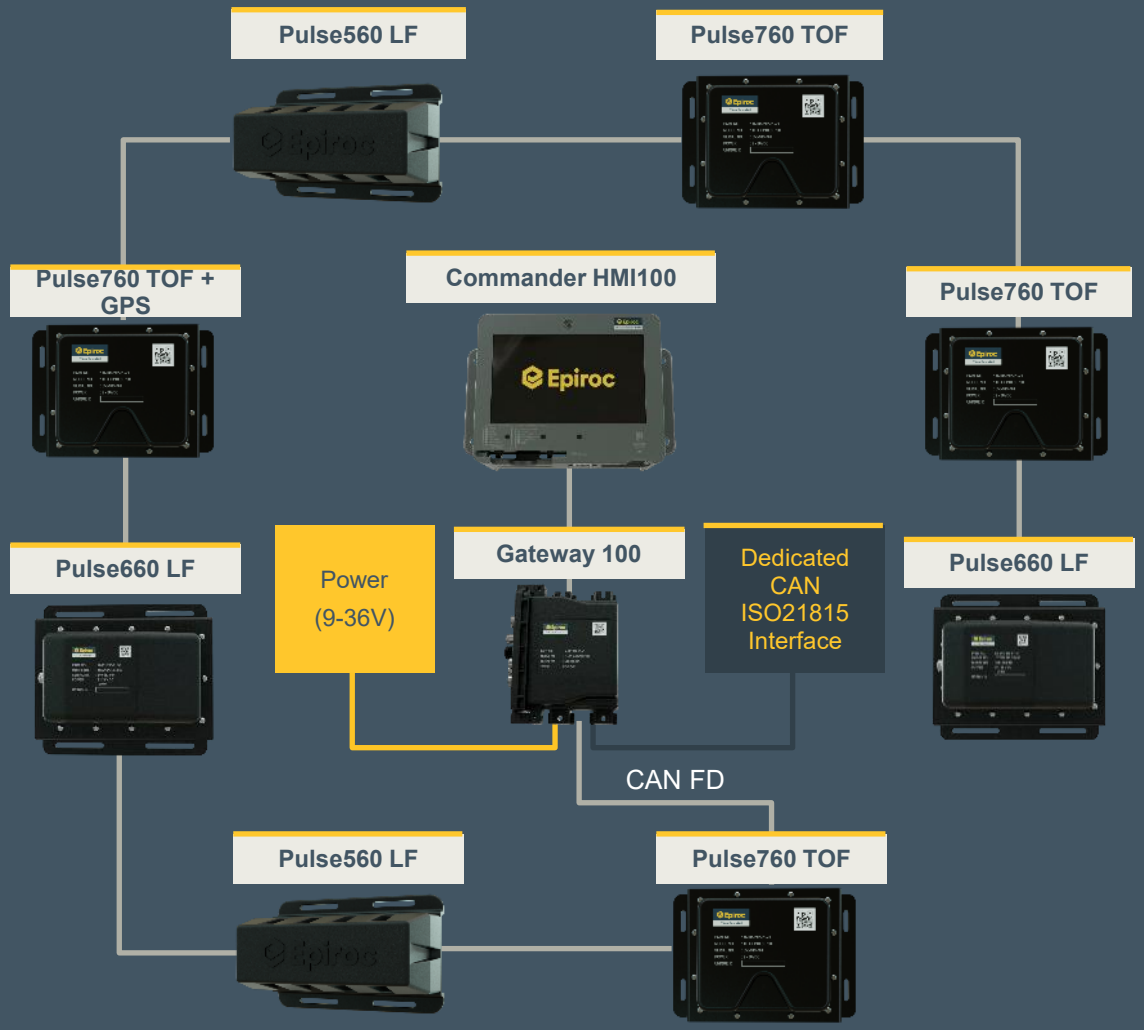
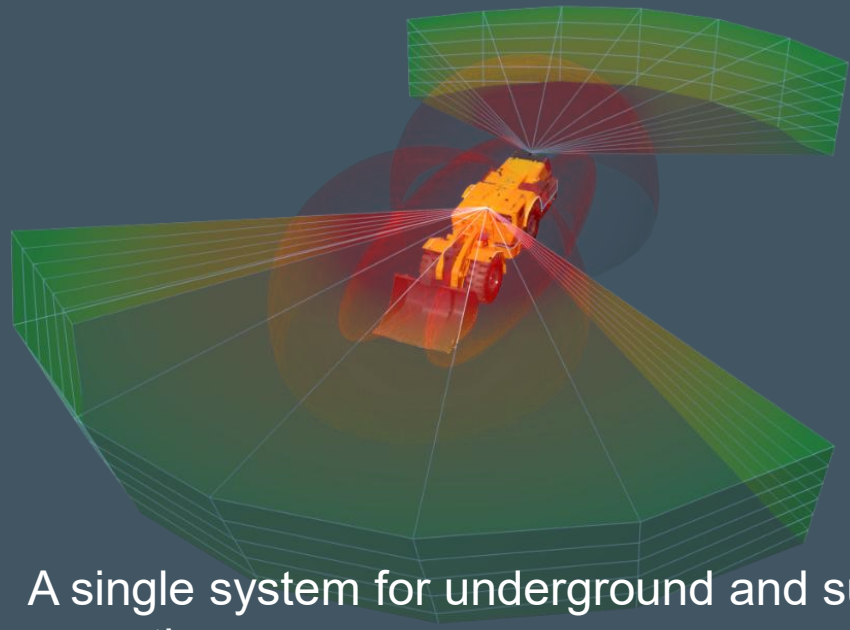
Technology	Accuracy/ Repeatability	Range	Data bandwidth	Object penetration	Advantages	Limitations
LF field generation	🟢	🔴	🔴	🟢	Repeatability and obstacle penetration	Range
Sub-GHz RF	🔴	🟡	🟡	🟠	Establishes high bandwidth communication at range	Accuracy
GPS	🟡	🟢	–	🔴	Limited external hardware requirement Reliability	Surface only
Time-of-flight	🟢	🟡	🟢	🔴	Accuracy	No object penetration
AI vision	🟡	🔴	–	–	Detects untagged objects and personnel	Light sensitive Inconclusive
~~Radar + LiDAR~~	⚫	⚫	–	–	Detects untagged objects and personnel	Inconclusive without other sensing technology
Titan CAS	🟢	🟢	🟢	🟢		

Legend: 🟢 Very high 🟡 High 🟠 Medium 🔴 Low

System overview

Modular layout – Just 1 or multiple sensors





- A single system for underground and surface operations
- Machine OEM agnostic through ISO21815
- Pain-free level-7/8 to level-9 conversion
- A design that considers the limitations of each technology used in the industry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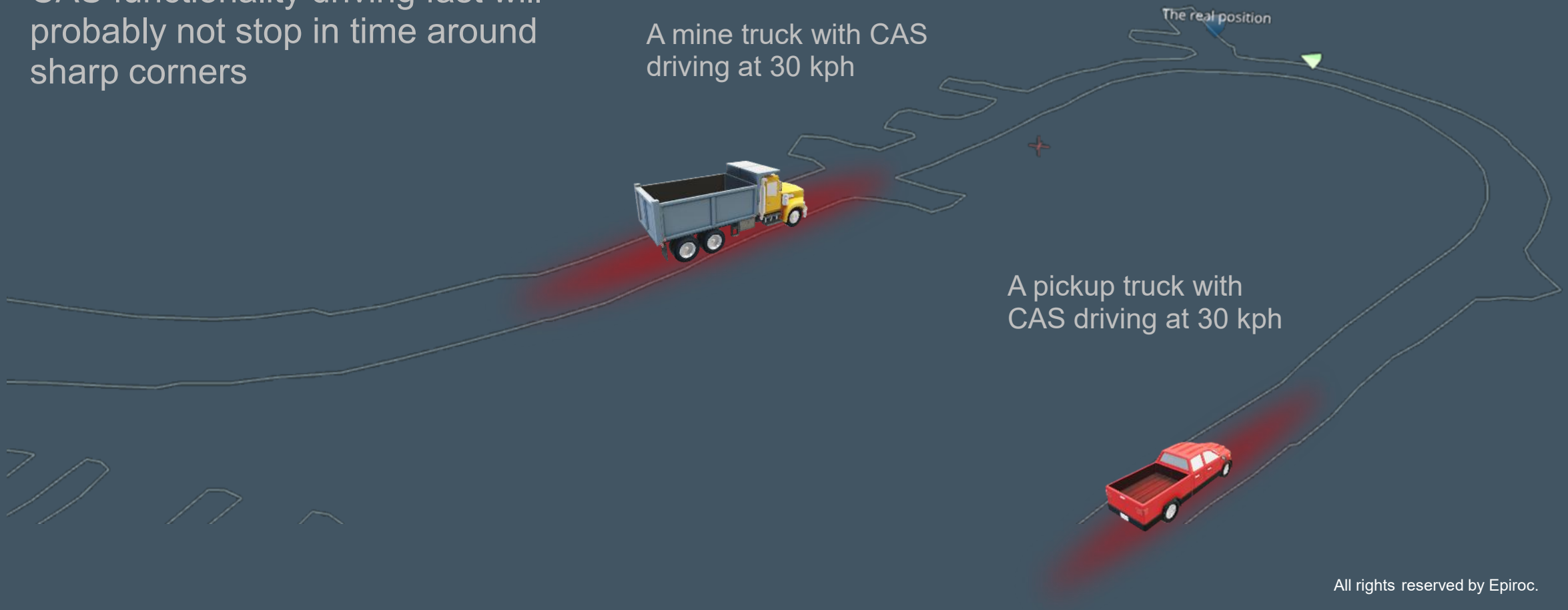
Single solutions
might be good, but won’t
cover all scenarios

CAS alone does not cover all situations

Vehicle – Vehicle (V2V) with fast driving vehicles

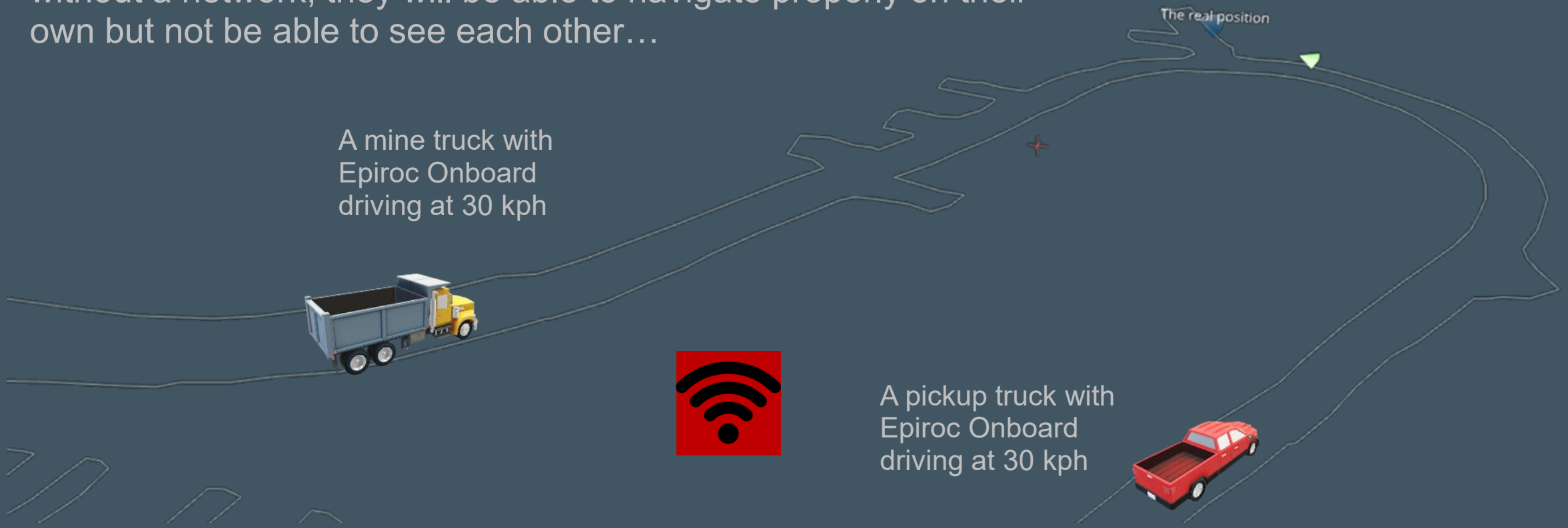
In the case that two vehicles with CAS functionality driving fast will probably not stop in time around sharp corners



Onboard alone does not cover all situations

Vehicle – Vehicle (V2V) in areas with no networks

In the case that two vehicles with Onboard driving fast in an area without a network, they will be able to navigate properly on their own but not be able to see each other…



Onboard alone does not cover all situations

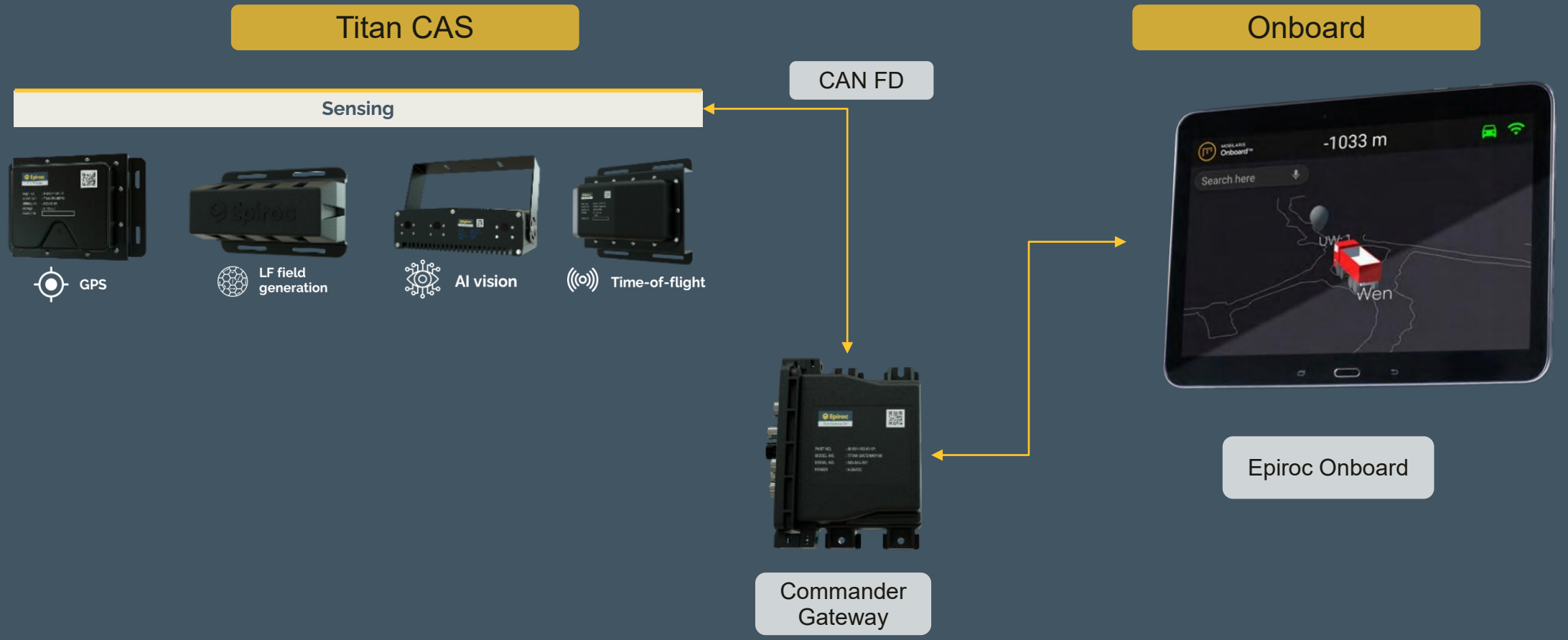
Vehicle – Person (V2P)

A vehicle with Onboard driving fast will not be able to get accurate warnings of people as people tracking usually is done with not accurate enough precision and depending on network


The combined solution
1+1 > 2

State of Play

Continuous improvements for a truly integrated solution



The best of two worlds

Vehicle-vehicle both long range and close proximity and Vehicle-person close proximity

Epiroc Onboard capabilities

Navigation - Anyone can navigate to anywhere anytime (go to the right place faster)

Traffic Awareness – Drivers can become aware of any incoming vehicles (V2V) within 600 meters in advance (where networks are available)

Situational Awareness – Anyone can look-up what is happening in the mine (faster decisions and less voice comm to the control room)

Safety – Drivers can quickly get the routes to the three closest refuge stations

Titan CAS capabilities

V2V (Vehicle-Vehicle) and V2P (Vehicle-People) EMESRT Level 7, 8 & 9 enabled

- From Collision Awareness to Collision Avoidance

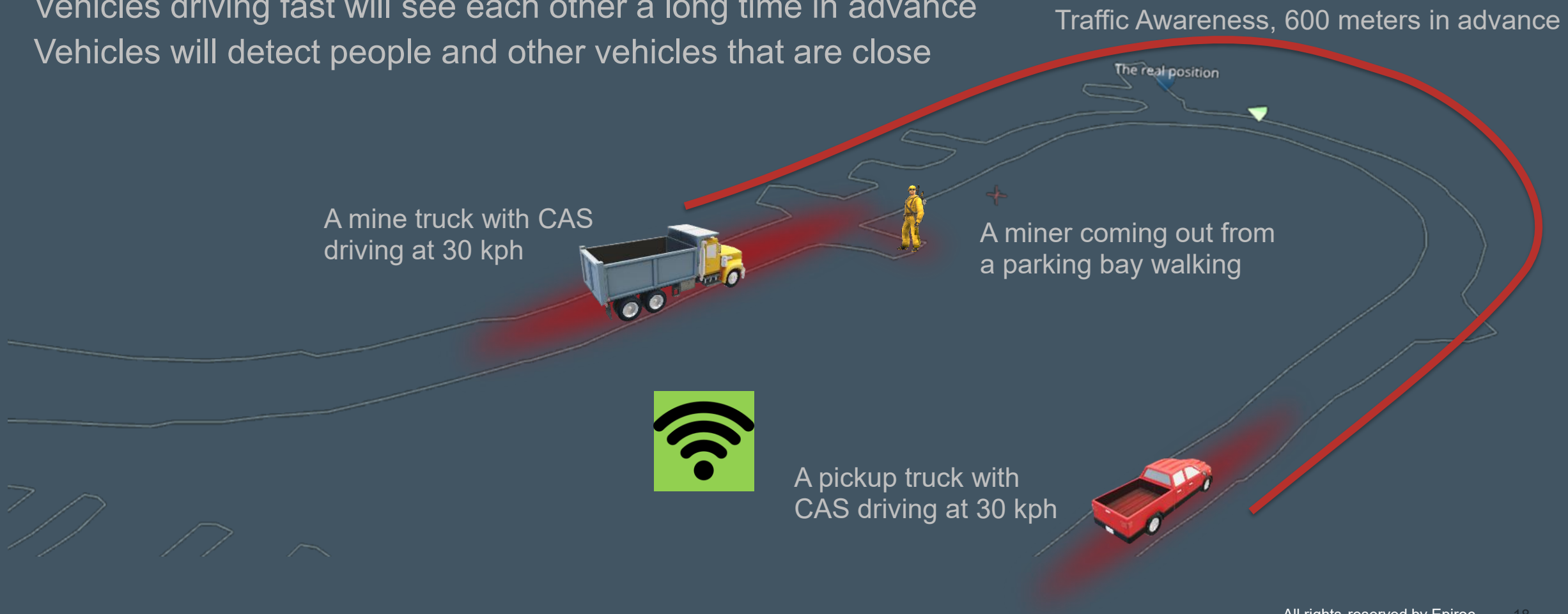
Huge range of options to ensure an optimal CAW/CAS functionality

- Single or multiple sensors
- Combined technologies UWB ToF, Magnetic Field sensors, AI, GPS etc

Onboard and CAS together saves the day

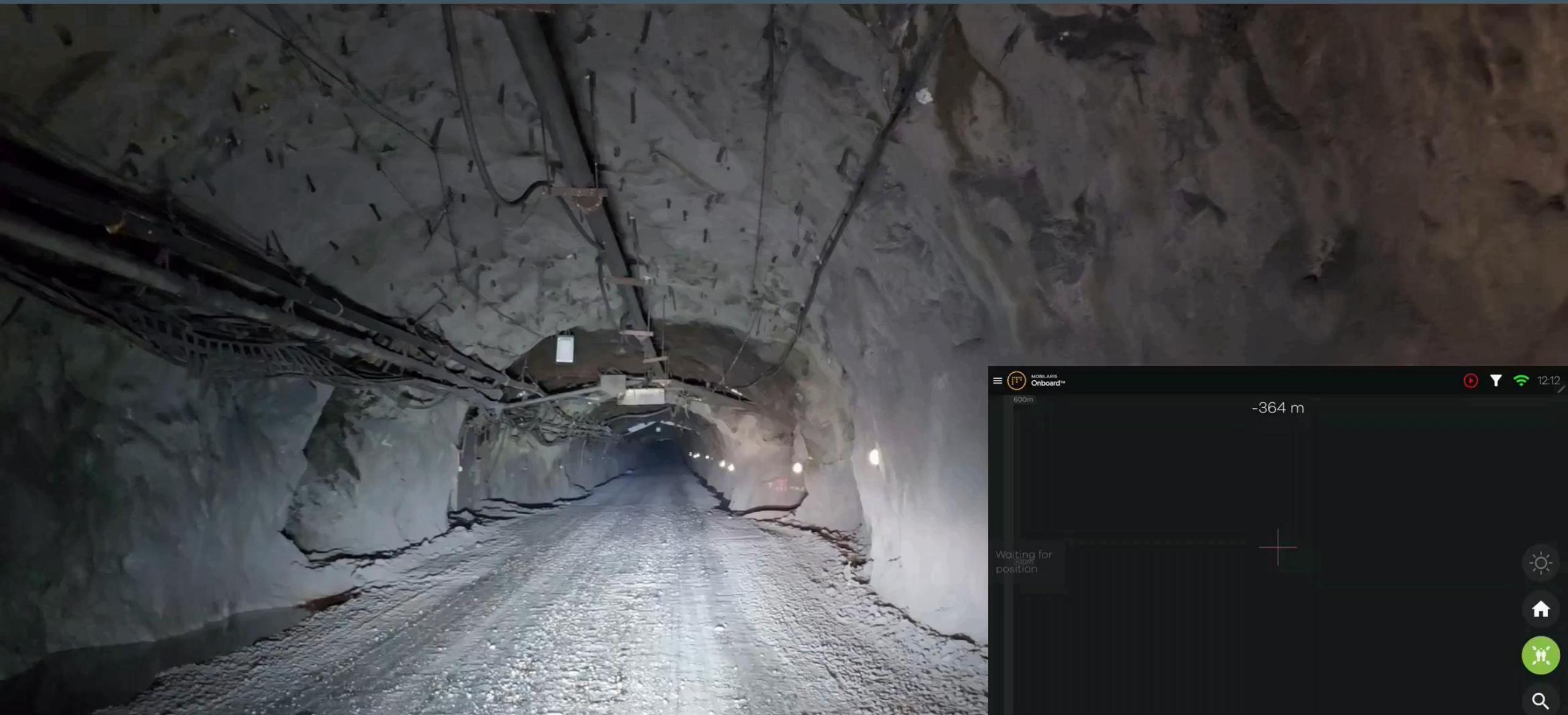
V2V and V2P long-range and in close proximity

Vehicles driving fast will see each other a long time in advance
Vehicles will detect people and other vehicles that are close



Demo of UI integration

Epiroc Onboard and Titan CAS



Conclusion

- A combined solution becomes the best of two worlds
  - Long-range Traffic Awareness minimizes traffic situations which increases safety and productivity (higher traffic flow)
  - CAS system level 7-9 secures nearby collision threats vehicle-vehicle and vehicle-person
  - One combined user interface, less clutter, better use of in cabin real estate
- Works in mines with or without network coverage
- CAS sensors can be tailored per vehicle type, scenarios and based on the risk assessment

- Combine the high-level awareness and navigation aid of Onboard, with the detection technology of the Titan CAS system
- CAS for detection of nearby collision threats, personnel, pinch points, inhibit zones
- Epiroc Onboard for long-range awareness
- A single user interface that the operator interacts with

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