LSM TrainSense®(int.pat.pend) Rail Level Crossing (CAAS) Collision Awareness / Avoidance System Concept Fact Sheet

Peter Woodford

(peter.woodford@lsm.com.au)

LSM Technologies

28/05/2024

Table of Contents

STRICTLY IN COMMERCIAL CONFIDENCE

1. INTRODUCTION / SUMMARY.

It is common knowledge that there are serious On- road safety issues related to Railway Level Crossings.

Rail Level Crossing Incidents involving many On- road vehicles are continuing to escalate in Australia (Globally) and there does not seem to be a solution to abate the situation.

Also similarly, to Over- height structure (Bridges / Tunnels / etc) impacts, Railway Level Crossing incidents cost many hundreds of million$$ in damaged infrastructure (and vehicles / loads), traffic delays, emergency responses, injury / fatality and more.

Such incidents are virtually an everyday event here in Australia- least alone the rest of the world where they have the same, if not greater issues.

The LSM Technologies Australian OH&S mitigation device development concept consists of 2 x Patent Pending Applications:

- LSM **BridgeSense**® (int.pat.pend) *Vehicle Over- height (CAAS) Collision Awareness / Avoidance System*: designed to eliminate / avoid Over- height Vehicles / Loads and Over- width impacting on Bridges / Tunnels (overhead structures), as well as providing Over Bridge protection from vehicle mass.
- LSM **TrainSense®** (int.pat.pend) *Rail Level Crossing (CAAS) Collision Awareness / Avoidance System*: designed to eliminate / avoid Rail mounted Vehicle impacts with other Road Vehicles travelling over these Crossings.

This Technical document is specifically about the LSM **TrainSense**® concept.

However, whilst there are 2 x Patent Pending for 2 x **separate** mitigation devices, pragmatically the concept is to combine the functions / feature of the LSM **BridgeSense®** + LSM **TrainSense™** technology into a **Singular Combined** Safety Mitigation Device.

Please also refer to the LSM BridgeSense® Technical Discussion Paper at this link 2023- LSM BridgeSense® (int.pat.pend) Over- Height CAS V3.pdf

Subsequently, LSM Technologies is reaching out to respective Australian (and later International) Government Authorities to start a conversation to ascertain if there is an interest in supporting / funding our proposed mitigation control(s).

2. BACKGROUND.

Collisions / Vehicle interactions with Railway / Track Vehicles on **Rail Level Crossings** are a frequent occurrence that cause significant delays along busy traffic routes and damage to critical infrastructure. This can cause prolonged road / rail closures and require expensive repairs in the **hundreds of $$million** to vehicles, equipment and infrastructure. These collisions can also result in significant injuries / fatalities to the driver(s), pedestrians and others.

Whilst it is clear that collision mitigation is important, current technologies such as **boom gates, flashing warning lights / bells (Active)** and **static (Passive) Stop / Give Way Signs** are **costly** to implement and **unreliable**.

■ Technical Sheet: LSM TrainSense® (Int.Pat.Pend)

3. ROAD / RAIL VEHICLE INTERACTIONS.

A few statistics for **Australia** and **Internationally** are:

Australia

- **2024**: There are more than **23,500 railway level crossings** in Australia. **21%** of level crossings "**Active**" (Boom gates, etc). The remaining **79%** of level crossings are "**Passive**", meaning the majority of them have only "**Stop**"' or "**Give Way**" signs.
- **2024**: There are over **1,000** near "**hits**" (misses) between vehicles and trains at level crossings **annually**. A near hit is when a train driver applies the emergency brakes and the train narrowly misses colliding with a truck, car, cyclist or pedestrian. The difference between a fatal collision and a near collision at a railway level crossing can be just seconds. Almost every near hit and incident is due to the road user doing the wrong thing, either through **error** or **deliberately**.
- **2024**: It can take a fully loaded freight train up to **2.0km to stop** after the emergency brakes have been applied.
- **2024**: Until recently, there were around **30 fatalities** every year resulting from level crossing collisions. These numbers are declining; however, there are still multiple fatalities every year and collisions resulting in serious injuries.
- **2024**: National Transport Research Organisation (**NTRO**) rail executive director Natalie Loughborough says that, with more than 23,000 level crossings across Australia, there is no **silver bullet** to fixing the Australian level crossing safety problem.
- **2024**: **TrackSafe** Foundation executive director **Heather Neil** says the removal of all these **crossings** is an **unrealistic** possibility. Loughborough says that if **one crossing per week** was removed, it would still take *500 years* to remove every crossing.
- **2024**: Whilst Victoria has put in the work, the **level crossing toll** across Australia remains **high**. Between July 1, **2014**, and December 31, **2022**, the **NTRO** found that there's been **322 collisions, 49 serious injuries** and **39 fatalities** at these crossings involving either pedestrians or vehicles. On top of this, there were more than **7,839 near hits (misses)** during that period.
- **2024**: According to **ATSB** in the 6-year period from July **2015** to June **2021**, there were **211 collisions** involving **rail vehicles and road vehicles** at level crossings in Australia (about **35 per year**). Of these, **34 of the collisions** involved heavy road vehicles (that is, heavy freight vehicles or buses).

Example: Typical example of a **HPI (High Potential Incident) / near miss** is a recent incident in WA- see **LinkedIn article and video**

UK / EU

- **2021**: There are nearly **6,000 level crossings** on the rail network across **England, Wales and Scotland.**
- **2021**: Around **96 000 level crossings** were reported in the **EU-27 Member States**, with **passive** level crossings accounting for around **42% of the total**.
- **2021**: In the **UK**, between **2010 and 2020,** there were **16,344 recorded near misses** between trains and road vehicles, and **87 collisions** leading to **19 fatalities**.

USA

- **2023**: There are more than **212,000** Grade (**Active and Passive**) Railway level crossings in the US.
- **2024**: According to **FRA** statistics, **2,202 highway-rail grade crossing collisions** occurred in **2022** consisting of **269 fatalities** and **827 injuries**.
- **2022:** More than 60% of collisions occur at crossings with automatic warning systems and TDA Rail Crossing Collision Fact Sheet- USA states that **Driver inattention** is considered a major cause.
- **2021:** According to the US Senate Committee - Railroad crossing report, **driver behaviour (error)** is the **main reason** for railroad collisions.
- **2019:** It is estimated that railroad crossing incidents cost **$1.7 billion**; **$17 billion** over the past **decade**.

Canada

- **2023**: There are about **14,000** public and **9,000** private grade crossings along more than **40,000** kilometres of Federally - regulated railway tracks in Canada.

4. CURRENT RAILWAY LEVEL MITIGATION TECHNOLOGY / ISSUES.

Railway Level Crossings Safety Mitigation Controls are usually either provided as a **"Passive" or "Active"** system.

4.1 Current (Passive) Mitigation Controls.

Passive mitigation systems are to simply provide static warning signs such as **Stop** or **Give Way** to warn the driver to be **aware / stop** and **check** that there is no approaching Rail Vehicle before proceeding over the Crossing.

Known issues with these mitigation controls are:

- Most of these Crossings are remote where there is no power available for **Active** warnings.
- **Maintenance** is costly due to remoteness should **Active** mitigation systems be installed.
- Approaching Road User may **not** become **aware** of the Crossing, especially when travelling at **speed**, if **distracted** or **poor visibility** (night, heavy rain, on tight bends, obscured - e.g. trees).
- Human **distraction** / **error,** or even **deliberate** crossing.

4.2 Current (Active) Mitigation Controls.

Active systems are where Trackside Switches are positioned on the track where a Train will trigger large **Flashing Lights / Audible Bells** and some Railway Crossing also have **Boom Gates** that close.

Known issues with these mitigation controls are:

- Road Vehicle User blatantly **disregard** to audible and visual **warnings (no Boom Gates)**.
- Road User travelling at **speed, distraction** of **poor visibility** (night, heavy rain, on tight bends, obscured - e.g. trees).
- In- Vehicle **noise** (**music**, etc)- cannot hear Crossing audible warnings.
- Human **distraction** / **error,** or even **deliberate** crossing.

- **Maintenance** is costly due to remoteness should **Active** mitigation systems be installed.

4.3 Error / Distraction / Complacency / Situational Awareness

Human Error and other causations are contributing factors as to why existing "**Passive**" and "**Active**" types of mitigation controls for Railway Level Crossings are **not affective solutions**:

- Wherever there is a need for "**human**" interaction, then there is a significant **potential** for an incident due to **delay** in responding / taking action.
- **Human Error** (**see link to NRSPP**) and **Distraction** (**see link to NRSPP**) are perceived as **big issues**.
- **Complacency** is a contributing factor, where a Driver can become "**blinded**" (does not "see") warning signs or even flashing lights and even boom gates.
- **Situation Awareness > Decision > Acton - Response** (see this link) takes time to implement corrective action. It is known that a driver can take between **1.5- 2.5 seconds** (or longer with **fatigue**) to become **Aware** there is a need to take action. **Thinking** time is required to make a **Decision** for corrective **Action** (e.g. start to apply brakes). For a Truck and single Trailer, it takes about **4.6 seconds** to bring the Rig to a stop - longer for larger Rigs
- At **100 km / hour** in- **dry conditions,** stopping distance can be >**200 metres**, With longer Rigs, **wet** conditions, braking distance can again take a **lot longer**.
- Utilising a fully autonomous technology of LSM **TrainSense**® provides the Driver with a pre-warning of the presence of a Railway Level Crossing and can initiate **deceleration** or even **AEB** (Automatic Emergency Braking) if required.

4.4 Other Mitigation Controls

As described in our LSM **BridgeSense**® *Over - Height / Dimensions CAAS* mitigation control **Google Maps** Apps, In- vehicle **Navigational devices** and **Online Route Planning** systems are available for depicting Railway Level Crossing's. Please see our LSM **BridgeSense**® section to read why these systems are believed to be **unreliable** and **ineffective** as mitigation controls.

4.5 Heavy Penalties

Other **significant countermeasures** by Regulators have been to apply **heavy $$ penalties, removal of offending Trucks / Drivers from operating** and even **threatening incarceration** of Transport Operators / Driver for breaching current mitigation controls.

However, whilst such penalties make act as some determent, they are not a "**proactive**" mitigation control, and are applied **"after- the fact"** of a possible **catastrophic** event, severe costs **damage / repairs / disruption**, **injury / fatality** and really will **not** be a permanent "fix" to stopping On Road and Rail Track Vehicle interactions around the **world**.

5. LSM TRAINSENSE®- HOW - IT- WORKS.

5.1 LSM TrainSense®- Device Functionality

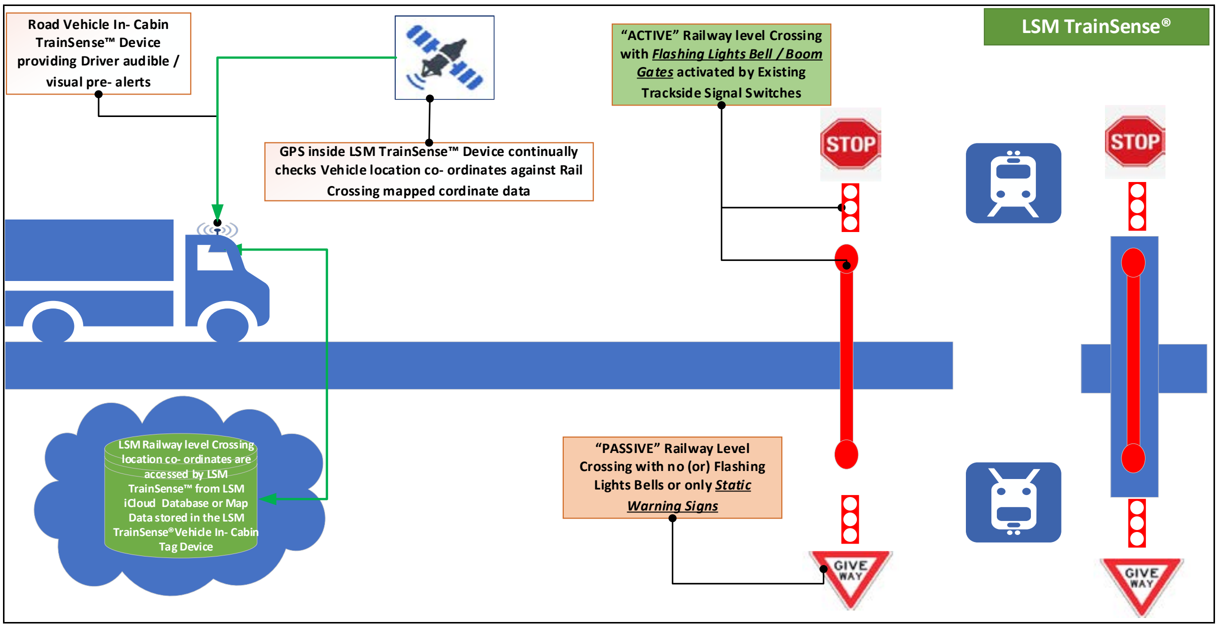
As detailed in the previous section, Error / Distraction / Complacency / Situational Awareness are perceived as some of the most **significant hurdles** to overcome to avoid interaction between On- Road and On- Track Vehicles at Railway Level Crossings.

Subsequently, it is apparent that a **proactive Vehicle In- Cabin Warning Device** concept such as LSM **TrainSense**® that provides (In- Cabin) **visual and audible** alerts to the Driver as they **approach** a Railway Level Crossing, could be the **ideal solution**.

■ Technical Sheet: LSM TrainSense® (Int.Pat.Pend)

Below is a **schematic** of our LSM **TrainSense®** mitigation technology with the following overview / functionality of the Device concept.

- LSM **TrainSense**® would be suitable to provide a Driver warnings for both "**Passive**" and "**Active**" Railway Level Crossings.
- The concept is a small "**Puck**" (like a Toll Tag) **Device** that is permanently affixed inside the Cabin of the Vehicle, located behind the Cabin Rearview Mirror.
- The Device contains a stored Database of all **Mapped Railway Level Crossing** GPS **Co-ordinates**.
- Once the vehicle is **moving**, the Device constantly **compares** the stored **Railway Level Crossing GPS Co-ordinates** with **Vehicle Location Co-ordinates**.
- **Railway Level Crossing** GPS Co-ordinates are compared **dynamically** (as the **vehicle travels**) without any **Pre - route** planning or **Driver intervention** required.
- Should a Road Vehicle **approach** a Rail Level Crossing on its travel route, the Device will provide audible and visual warnings to the Driver. Warnings can be programmed into the Device to occur **multiple times** and at **any distance before** the Rail Level Crossing.



5.2 Other- Capabilities

The LSM **TrainSense**® concept can provide other capabilities / functions such as:

- Where the Device has **GSM Data (Sim Card)** Telematics, then **alerts / warnings** and other data can also be sent **back to base** to LSM FSM® **Fleet Safety (Tracking) Manager** or to an external iCloud Database.
- The standard LSM **TrainSense**® does not determine if there is an **"active" Rail Vehicle** on the Track **approaching** the Railway Level Crossing. However, where **Trackside Signal Activated Transmitters** are used, they could also send a **transmission** to the LSM **TrainSense**® to alert the On- road Vehicle Driver of an approaching Rail Track Vehicle.
- **Non - compliance** / **ignoring** (and other data) of warnings can also be **stored** on the Device.

- The LSM **TrainSense**® concept can also be configured to receive communications from **Trackside Sensor Transmitters** that can be used to send a **signal** to the on-Road Vehicle In- Cabin Device to warn the Vehicle Driver of an **approaching** Rail Track Vehicle on a Level Crossing (please see the notes below as this is **not necessarily** recommended).
- Can be programmed to **Decelerate** and / or apply **Braking** to mitigate an interaction if the Driver **ignores** the Device warnings - even applying **AEB** (Automatic Emergency Braking).
- Other functions / operations for the LSM **TrainSense**® concept can be considered.

5.3 TrackSide Sensor Transmitters / Remote Sign Nodes.

As mentioned above, **Trackside Sensor Transmitters** that can be used to:

- Send a **signal** to the LSM **TrainSense**® to alert the Vehicle Driver of an **approaching** Rail Track Vehicle on a Level Crossing.
- Convert "**passive**" Railway Level Crossings into "**active**" by the **TrackSide Sensor Transmitter** activating additionally installed Crossing **Flashing Lights / Audible Alarms** when a Train / Rail Vehicle approaches a Crossing.
- Activate (via RF / Lowra communication) **other Audible / Visual** warning signs at a distance (nodes) on the road **before** the Crossing to act as **pre - warning** as an On-road Vehicle approaches the Crossing.

Certainly, such **TrackSide Sensor Transmitters** would **augment** the LSM **TrainSense**® primary Driver alert features, but we feel that there are **some other risk** factors that may need to be considered:

These are:

- Usually such "**passive**" Railway Level Crossings are in **remote** areas where there is no conventional power and so rely on **Solar Power / Battery sources**, which could cause **power reliability** issues.
- Installation of such **Devices** as well as the **Audible / Visual Signage** will be **costly-** note **>70%** of Australian Railway Level Crossings are in remote regions and are "**passive**".
- **Maintenance** will be **expensive** and require additional **support infrastructure / personnel resources**, to **manage / service / repair** these Devices.
- **GSM Data / Telematics** will be needed to provide **back - to base** warnings should the **devices fail**. This again will require **GSM Data costs**, additional **support / management / monitoring resources** and **personnel** with associated **costs.**
- If the Devices (Transmitters / Sensors / Active Signage) fail then the **"fail- to- safe"** goes back to the traditional "**passive**" Stop / Give Way signs which really **defeats the purpose** of the installed Device.
- The **active** Warning Signage success is reliant on an **observant / undistracted Driver** noting the remote **Node**(s) and **Visual Pre- warnings** (where installed) and especially when travelling at speed.
- Does not address the "**Human Errors**" associated with Distraction / Complacency / Situational Awareness and Response Time.

■ Technical Sheet: LSM TrainSense® (Int.Pat.Pend)

Special Note: The most **significant** risk is where a Driver may develop the **expectation** is that if the **active** Warning Signage and the remote **Nodes fail** back to a **passive** state, that it is **safe** to continue at speed believing that there **is not** a Train / Rail Vehicle approaching the Crossing.

Consequently, we hold the belief that the most **effective** approach to mitigate the impact of an accident is to equip a Vehicle In- Cabin Device, such as LSM **TrainSense**®, with audible and visual alerts to the driver, and to trigger these alerts as the On-road Vehicle **approaches** a Railway Crossing, ***regardless of whether a Train or Rail Vehicle is to cross or not.***

5.4 LSM TrainSense®- Key Features

Some of the Key Benefits/ Features for the LSM **TrainSense**® concept are as follows:

- The **TrainSense**® is a **standalone** mitigation device that does not require any ongoing **subscription** or **telemetry** costs.
- No ongoing **maintenance,** no additional **support resources, infrastructure** or **personnel costs** are required**.** If the LSM **TrainSense®** Device **fails-** then it is replaced **quickly** and **simply** at low **cost**.
- GPS Satellite (not a car **Navigation** or **App**) network is **reliable**, **accurate** and **covers** all of **Australia** and the **World**.
- Mapped data can be manually updated with data changes or adding additional coordinates for **new Overhead structures** via either a ESim or BT via PDA / Phone App. Or with the telematics option, can be **updated** automatically **over - the - air**
- It is not a car **Navigation / Telematics device** that requires **pre - route** planning. LSM **TrainSense**® simply compares stored Railway Level Crossing GPS coordinate in the Device (or iCloud Database) against the Vehicle's / Load stored Height data of the vehicle as it is **motion- dynamically**.
- **Other features** can be designed into the Device, such as telematics for **back- to - base** reporting (e.g. LSM FSM® Fleet Safety (Tracking) Manager)
- Can be used to provide **Deceleration** of the vehicle, **Braking** or even **AEB** is alerts are ignored.

5.5 LSM TrainSense® + LSM BridgeSense® Combination.

As with **Railway Level Crossing incidents**, the costs for **Over - Height Bridge / Structure Impacts** also cause many **$100's of millions** for **maintenance**, **emergency response**, **repairs**, **traffic delays** and **injury / fatalitie**s, etc.

Subsequently, it is **pragmatic** and **cost-effective** to **combine** the functions / features of both LSM **BridgeSense**® + LSM **TrainSense**® technology's into a **Singular Safety Mitigation Device**.

6. IMPLEMENTATION / COST / SAVINGS.

To ensure the effectiveness of the LSM **TrainSense**®, it is envisaged that the Vehicle In- Cabin Device would need to be **mandated** for every On- Road Heavy / Commercial Vehicle (e.g. Trucks).

Mandating can simply be provided via legislation / ADR that all On- road Commercial Vehicles Trucks / Heavy Vehicles (new and existing) are to be fitted with LSM **TrainSense**® Device.

Not only would LSM **TrainSense**® provide **significant** savings (traffic delays, repairs, emergency response, etc and lives) but also the costs for the LSM **TrainSense**® can be **recoverable**.

Concept for cost recovery for the LSM **TrainSense**® would be:

Technical Sheet: LSM TrainSense® (Int.Pat.Pend)

- A slight annual increase in Truck **registration** to recover the outlay for the LSM **TrainSense**® Vehicle In- Cabin Device.
- In addition, the concept could be integrated into Vehicles at manufacture via an ADR.
- It should also be considered that the LSM **TrainSense** and the LSM **BridgeSense**® be developed as a **Singular** Vehicle In- Cabin Device that can provide for both **On- Road (Over + Under) Bridge** and **Railway Level Crossing** Safety Mitigation Control.

7. DEVELOPMENT / COST

To be effective, it is envisaged that LSM **TrainSense**® requires to be installed on **all** respective Commercial Vehicles and as such, the support of the respective **Australian** (or **International**) Government / Authorities is needed to accept / to fund the development of LSM **TrainSense**®.

At this time, it is envisaged that the development costs to be estimated at **$1- $2 million** and **LSM Technologies** are seeking such funding at the moment- please Contact Us to start the conversation.

8. SUMMARY / CONCLUSION.

Overall, these benefits paint a compelling picture for the adoption of LSM **TrainSense**® Safety Mitigation control, highlighting both the immediate and long-term advantages for the government, the public, and the economy as a whole.

- **Low Cost Development**: The implementation of LSM **TrainSense**® Safety Mitigation control promises to be cost-effective in its development phase. This means that the initial investment required from the government would likely be low, and there's potential for the costs to be fully recovered or even generate a return (e.g. slight increase in vehicle registration). This aspect would appeal to decision-makers concerned about budgetary constraints.
- **Savings in Lives, Injuries, and Infrastructure Costs**: If LSM **TrainSense**® is effective, this mitigation control would lead to significant savings in terms of lives saved, injuries prevented, and reduced costs associated with additional infrastructure, road closures, traffic congestion, repairs, and emergency responder interventions. These savings have tangible economic benefits and contribute to enhancing transport / rail operators and public safety and well-being.
- **Creation of a New Industry and Economic Opportunities**: Implementing LSM **TrainSense** ® Safety Mitigation controls has the potential to stimulate the growth of a new industry within Australia. This could lead to the creation of job opportunities, tax contributions, and economic growth. Moreover, there's the added potential for substantial export sales, which could bolster the economy further by tapping into international markets and diversifying revenue streams.
- **Promotion of Australian Sovereignty and Technology**: By retaining the development and manufacturing of LSM **TrainSense**® within Australia, the country can safeguard its sovereignty and reduce dependence on foreign technologies. This aligns with initiatives such as "The Future Made in Australia Act," championed by the Australian Government - Anthony Albanese - which aims to bolster domestic technological capabilities and ensure that Australia remains competitive in the global landscape.

Our objectives at this time is to reach out to those Authorities that maybe interested in starting a more detail conversation about our proposed LSM BridgeSense® (int.pat.pend) and LSM TrainSense**®** (int.pat.pend).

Subsequently, we look forward to hearing from interested stakeholders in our Transport and Road Infrastructure Authorities.