FASTTRACK

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INSIDE THIS ISSUE – WHAT IS SHAPING THE RAIL INDUSTRY TODAY AND INTO THE FUTURE

P2 Powering change differently – Aurizon – Kaylee Doyle

P3 Using AI to improve people and plant safety on site - Ginny Kaur

P5 A new way to monitor speeds – Sigma Pervin

P7 Is it time to take a break from track circuits? – Cameron Tippett

P9 Virtual coupling Signalling Systems- Aris Hosikian

P10 Strengthening The Core – Using an Enterprise Integration Platform to ensure the accuracy of Weighbridge Data- Bryce Garrett

P12 Turning recycled plastics into railway sleepers- Luke Veralla

P13 New initiatives to further harmonise advanced train control systems – Kawtar Hadjadj

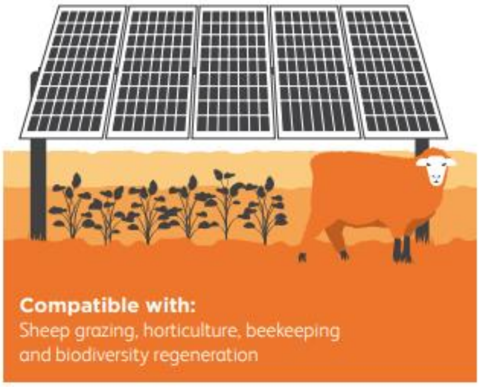
Powering change differently

Since the early 2000's, Australia has seen the development of solar power grow from an expensive system available only to forward-thinking entrepreneurs to almost 3 million households now enjoying the benefits of rooftop solar. As the sector has grown and more interest in exploring and promoting new models for complementary solar energy is invested in, many have thought 'how can we do solar differently?'. An outcome of these questions has led to greater investments in 'agrisolar'.

What is agrisolar?

Agrisolar is co-developing the same area of land for both solar photovoltaic (PV) power as well as for agriculture. Numerous forms of agrisolar have been developed around the world with a wide range of innovative approaches emerging in recent years.

Forms of agrisolar



How could agrisolar benefit rail?

As rail organisations invest in the research and development of new technologies to reduce their carbon footprint, many organisations are also exploring opportunities to participate in carbon markets by generating and/purchasing high-quality, verified carbon credits. These may be used to offset 'hard-to abate' emissions across their portfolios.

For organisations that utilise electrified networks, the benefits of agrisolar may be two-fold. The organisation may be eligible for Renewable Energy Certificates (RECs) and be able to use to generated electricity to power the electrified network. When combined with an agricultural programme, eligibility opportunities for Emission Reduction Funds may also be created.

Using AI to improve people and plant safety on site

In Australia, every 7 seconds a worker is injured on the job, and more than 60 per cent of workplace fatalities are vehicle related. The varying size and inherent blind spots of construction machinery in the rail corridors assigns a moral and economic obligation to an organisation to protect people working within this dynamic environment.

Currently, Sydney Trains is investigating ways to reduce such risk in the rail industry and better control the segregation of people and plant. As part of the "Separation of people and plant" initiative within in the Engineering and Maintenance branch, many approaches are being explored alongside traditional elimination and substitution risk reduction strategies currently in place. In addition, harnessing technology as additional engineering control is of particular focus. Proximity Detection Technologies are being examined to enable early warning for on-foot workers and plant operators when they come into close contact.

A proximity detection system is a system which detects the presence of other nearby plant or personnel. This system can be used for event logging as well as collision notification. These systems are helpful with providing an early warning indication that alerts the operator to the presence and number of personnel and vehicles in the immediate vicinity. Proximity detection systems also notify the people if they trespass the exclusion zone around operating plant. This is especially useful in adverse environmental conditions such as dust, fog and rain. These systems are widely utilised in the mining industry where they have been proven to be successful.

Among the different suppliers and technologies tested by Sydney Trains, of most recent is the proximity detection which harnesses AI vision technology developed by Presien, a start-up originating from Laing O'Rourke's Technology & Innovation Group. The product called 'Blindsight' is a standalone AI system that can be easily installed on vehicles and fixed infrastructure, becoming an operators extra set of eyes. It detects a dangerous situation, alerting workers to a risk before it becomes an accident. Integrated sensors and neural network AI software sees, understands, and alerts operators, using in cab light, haptics, sound and vibration alerts to potential hazards in real time. The AI technology uses machine learning logarithms to reduce the number of false detections and has real time monitoring capability to enable incident debriefing. Data is then captured and stored in cloud database.

From using this system, Sydney Trains aims:

- To capture quantitative near-miss data which are sparse in rail construction industry to help define a baseline,
- Understand and improve practices proactively using analytics.
- With maturity, the system can have strategic benefits to analyse trends such as blind spots, problem areas, personnel that consistently breach exclusion zones and timings.

It is hoped the analytics will then translate to targeted strategies which change behaviours of both operators and worker to improve safety.

A new way to monitor speed

Safety is paramount in any railway operations. Australia has advanced and continues to advance in implementing more automated and smarter systems/controls onboard the Light Rail Vehicles to reduce driver error and assist in safety. Some examples that Canberra Metro Light Rail (CMET) rely on in day-to-day operations include:

- Radio control
- Safety, track, service and emergency Brakes
- Alarms and warnings

One of the common safety issues identified on any Light Rail network in Australia is the number of emergency braking (EB) being applied. This is because light rail vehicles share the road with members of the public (MoP) and road motor vehicles, thus leading to higher chance of applying emergency braking, especially in congested areas such as Sydney and Melbourne. However, due to the increase in population in Canberra over the last several years, the number of emergency braking are increasing for the Canberra Light Rail (CMET). The prominent causes for CMET are due to:

- Driver distraction
- Driver error (to avoid LRTAE or accidentally activated EB)

Or could be external factors that CMET cannot control:

- Inattentive MoP
- Road Motor Vehicles running a red light
- Environmental conditions- fog or poor lighting

The consequences of emergency braking include:

- Onboard passenger injuries (passengers either sitting or standing may fall over due to certain jerk rate being applied).
- Increased braking may degrade the performance of braking over time.
- May have mental health impacts on the LRV driver following emergency brake incidents
- May lead to impact on service running of LRVs
- May decrease patronage due to passenger discomfort during emergency braking

An investigation into the movement of passengers and objects on light rail vehicles during emergency braking was done, which was part of the *Journal of Public Transportation, Vol. 19, No.4, 2016.* The investigation confirmed for the LRVs driving on a straight track, unrestrained people and objects onboard the LRV during EBs were projected forward or displaced from their position. This was a maximum acceleration of 0.398 g.

As part of good risk management practice, it is impertinent to have a mix of hierarchy controls – one of them must be an Administrative type involving driver (human) interface, perception and expertise in this case.

CMET's Service Delivery team have recently reviewed their current driver mentoring and monitoring processes and developed a Speed Monitoring Procedure which will assist LRV drivers when:

- LRV Drivers are over-speeding in particular areas by comparing the LRV speed with the posted track speeds before an incident occurred.
- Applying Emergency Braking to avoid collision or LRTAE
- LRV driver has collided with MoP or Road Motor Vehicle, to measure the speed before and after collision.

This method has been adopted from the Gold Coast Light Rail.

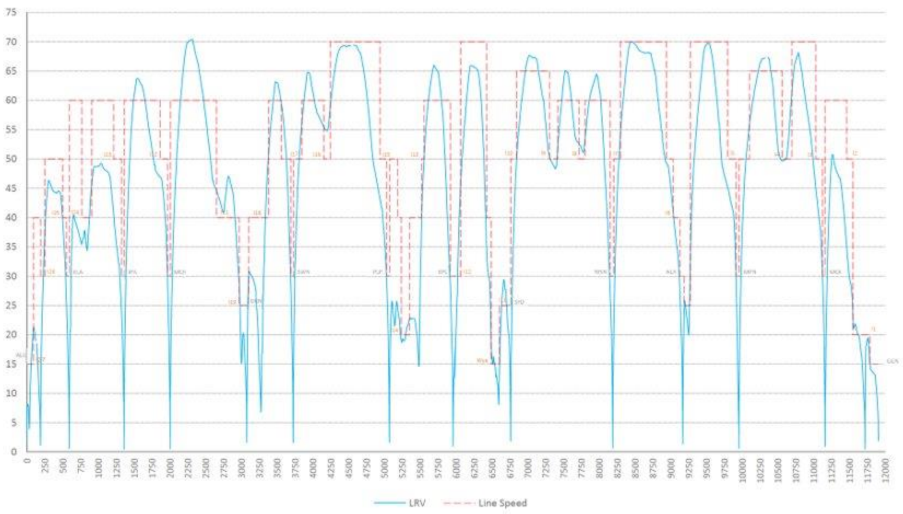
Speed Monitoring process

The process involves:

1. Downloading the LRV speed data from the T-visor (real-time monitoring system of LRV and other asset's functional outputs and characteristics).
2. This is saved onto a thumb drive
3. This is then overlayed with the posted track speeds from the 'speed check' formulated excel spreadsheet.
4. Data is viewed on the 'Speed Graph Overview'- an excel based calculation tool
5. In depth analysis is done via the 'speed graph extended'- an excel based calculation tool

The monitoring is done randomly, or when requested by the Service Delivery Manager or Driver Manager. All speed diagrams are saved under each driver's name in the training portal. These are then used as an aid during the consultation and driver feedback and mentoring process with the driver.

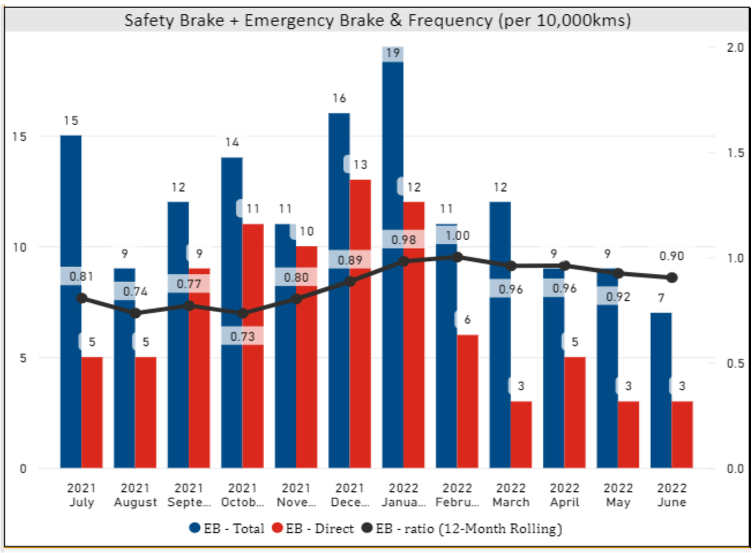
An example of a speed data overlay diagram is shown below for a particular trip, which is from Alinga Stop to Gungahlin Stop:



The blue line shows the LRV’s speed, and the red dotted line is the track’s posted speed along the intersections and stops. The x-axis presents the chainages in metres and y axis is the speed in kilometres.

Results

Since CMET have just started this process in May 2022, any real trends in total Emergency Braking are not apparent. However, as of June 2022, the total Emergency Brake (blue columns) graph from Powerbi below shows it is trending down from May 2022.



This result implies that this feedback mechanism after certain incidents is working for the LRV drivers.

Positive impacts in the long term:

- Meeting Operational and Safety KPIs
- Increase in LRV driver awareness and performance
- This enables the driver manager to identify any trends at any specific location/s for the driver to pay attention to
- Reduced onboard passenger injuries

Further improvements in this process are currently being assessed, such as using CAF’s Leadmind system to get the LRV speed data directly, which is already graphed for a particular LRV and trip. This would avoid the manual retrieving and graphing of the speed data points in the current process.

Is it time to take a break from Track Circuits?

Track circuits have been at the foundation of safe railway design since the early 1860s. Even after 160 years of technological advancement since their invention they remain as an elegant and effective control against collision events. However, as the design and operation of railways looks to the future, Rail Transport Operators (RTOs) in the heavy haul industry are now grappling with a tough decision – is it time to abandon track circuits completely in favour of new technologies?

The Downside of Track Circuits

The benefits of track circuits are well known- they provide a very reliable means of detecting track occupancy and their detection signals can easily be fed back into an ATP system to prevent impending collision event without needing to pass through an intermediary system (e.g. a signaling system).

Their downsides are less well known, mainly because there aren't very many and they aren't very notable. For heavy haul operators (i.e. those operating at ~40T axle loads) there is one key problem: undetected failures of Insulated Rail Joints (IRJs).

Failures of IRJs such as the one shown below are better described for what they really are: rail breaks. For networks that rely on track circuits to detect track continuity (i.e. rail breaks), most IRJ failures go undetected and hence there is no mechanism by which operations staff can intervene to prevent a train from traversing the break. For heavy haul operators, the loads exerted on the broken rail over the course of an entire train (some of which can be up to ~3km long) are enough to compound a small IRJ failure into one that can lead to a derailment – a costly and dangerous outcome.

Heavy haul operators looking to maximize their throughput and minimize their exposure to derailment risk need to look beyond track circuits to accomplish their goals.

The Challenges of Replacing Track Circuits

There are other 'systems' that can replace the functionality of track circuits albeit in a less elegant and more complicated fashion.

The table below outlines the most common approach taken to replace track circuits and illustrates that it is no simple feat – to replace functionality that track circuits provide three separate systems need to be deployed (an onboard GPS, axle counters, and a rail mounted Broken Rail Detection (BRD) system).

Each of these systems in isolation is far more complicated than a track circuit system in its design, installation, maintenance, and failure management. This begs the question on whether replacing track circuits is a demonstrably beneficial idea.

<table>
<tr><th colspan="3">Railway with Track Circuits</th><th colspan="3">Railway Without Track Circuits</th></tr>
<tr><th>System</th><th>Primary Function</th><th>Secondary Function</th><th>Secondary Function</th><th>Primary Function</th><th>System</th></tr>
<tr><td rowspan="3">Track Circuits</td><td rowspan="3">Detect track occupancy</td><td rowspan="2">Infer safe separation</td><td rowspan="2">Infer safe separation</td><td>Determine train location</td><td>Onboard GPS</td></tr>
<tr><td>Determine train length</td><td>Axle Counters</td></tr>
<tr><td>Infer track continuity</td><td colspan="2">Determine track continuity</td><td>Rail Mounted Broken Rail Detection (BRD) System</td></tr>
</table>

In Australia, RTOs are bound by legislation to design, operate and maintain their rail networks in a manner that is considered So Far As Is Reasonably Practicable (SFAIRP).

In the context of replacing track circuits, the SFAIRP standard sets a high bar for RTOs to meet as it implies that the systems they introduce to replace track circuits (which are each more complicated than a track circuit system) must be just as safe/reliable (if not more so) than their existing track circuit system.

This of course imposes a heavy burden on RTOs to both implement such systems and document robust evidence that that shows that these systems are in fact safer than track circuits.

The Final Verdict

Overall, while it is certainly possible to replace the functionality of track circuits with other systems, doing so comes with a burden. Any RTO that makes this decision will be unendingly responsible (ethically if not legally) for operating and maintaining a replacement set of systems to a performance level equal to that of track circuits.

This responsibility must be carefully weighed up against the potential benefit when making a decision to replace track circuits.

Virtual Coupling Signalling Systems

Rail operators aim to maximise the frequency of train services on their network without physically expanding existing networks, which is costly and often not feasible due to the high-density urban environment that metropolitan railways are located within. Therefore, to achieve this target, advanced signalling systems have been developed to safely reduce train separation and allow more frequent services to operate on existing networks. This article explains the Virtual Coupling System which further develops on the Moving-Block System by separating trains by a relative braking distance, which is the distance required for train to brake to same speed as the train ahead.

Traditional fixed-block signalling typically uses track circuits to detect the position of a train and divides track into small blocks that determines the separation required between trains. This system often requires the separation between trains to exceed the safe stopping distance between trains as the distance of separation is determined by the fixed blocks.

Moving block signalling uses CBTC (Communications Based Train Control) and can reduce train separation by having an adjustable safety distance based on a real time calculation of the train speed. Unlike the fixed block system which has a static safety distance in front of the train based on fixed block, the safety distance with the moving block system is dynamic (increases as the train speed increases and reduces as the train speed decreases) and corresponds to the distance required for the train to come to a stop. This reduces the required separation between trains to the safe stopping distance of the train.

The Virtual Coupling develops on the Moving block system by separating trains by a relative braking distance, the distance needed to slow down to the speed of the train ahead. In both Virtual Coupling and Mixed Block signalling, the trains communicate with trackside radio to report train position updates every few seconds. The computer system then calculates the minimum safe separation between trains. The Virtual Coupling System has an additional train to train communication layer, where trains exchange information about their speed, acceleration, and routes. By using the kinematic information shared between the trains, the Virtual Coupling System calculates the minimum safe separation based on the distance required for the train to slow down to the same speed as the train ahead.

The Virtual Coupling System minimises train separation and maximises the capacity of existing network. This System is most advantageous in high-speed networks.

Strengthening The Core - Using an Enterprise Integration Platform to ensure the accuracy of Weighbridge data

After a period of tremendous investment and network expansion, ARTC's strategic focus now is to bring more freight onto rail through a business transformation strategy.
In order to realise the potential established by the investment phase, the goal is to continue the transformation into a business that is committed to customer success.
ARTC adopted a Digital Strategy that included the initiative known as "Strengthening The Core (SCT)" as a component of this comprehensive corporate transformation strategy. STC's ultimate mission is to:

- Enhance the user experience.
- Resolve underlying technological problems.
- Establish a strong base.
- Expand over time.

In correlation with **Versor,** a company who excels at Digital and Data Analytic Strategies, ARTC implement their design for their integration platform identified as a need in Phase 1 of STC.

What were we trying to improve?
Along its route, ARTC has installed weighbridges that measure train weights as they pass by at up to 60 kph. This highly essential information is necessary for ARTC and their clients to accurately offer haulage weight details, analyse technical equipment, and verify that wagons have been loaded correctly.
To read these weights and use the information as needed, ARTC already had an internal solution. This solution, however, was not created to enable the precise collection of weights across all weighbridges and was not hosted in the cloud. Customers were being impacted, therefore ARTC made the decision to switch to an enterprise integration platform, which would enable a more efficient procedure and, more importantly, provide consistently accurate data.
ARTC developed an architecture design and blueprint for the new platform and asked Versor to implement this.

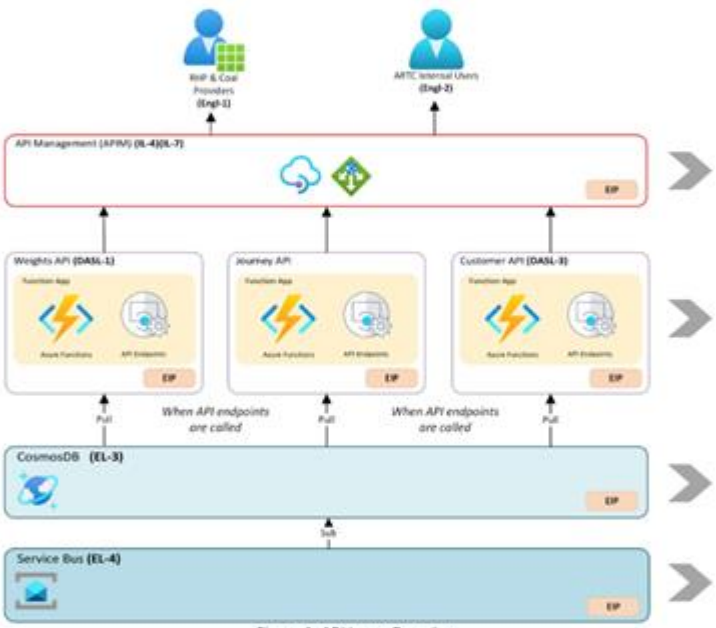


Figure 1: API Layer Overview

What was the solution?

Versor created an ingestion mechanism for the incoming data using Data Factory and Databricks based on the design and blueprint supplied by ARTC. This procedure correlates data from the train timetables, weighbridges, and train code lookup table to ascertain:

- Which train is where?
- The weight of the train.
- What time it crossed a particular weighbridge.
- Once this data has been pulled together, it is stored as a record in CosmosDB.

Versor needed to determine how to deliver this information to the appropriate individuals at the appropriate time. They created a number of RESTful APIs using Azure Function Apps as a result (hosted in Azure API Management).
These APIs provide easy access to the data for both internal and external users. This technology also makes sure that the data is secure and that customers may only access their own data by using the tags that are provided on specific wagons.

What were the results?

ARTC has made their data more accessible for the companies that require it by transitioning from their legacy in-house solution to an Enterprise Integration Platform by providing real-time data from the weighbridges. This allows for more accurate and efficient decision-making, resulting in a more reliable network for all parties involved.
Since the solution is hosted in Azure, there is less maintenance and downtime, and any infrastructure problems are remedied in accordance with Microsoft's SLAs.
With the help of this digital transformation, ARTC can now provide its customers a service that is more trustworthy.

What's next?

ARTC will be working with Versor again to assist them with the next stage of their digital transformation. A solution is being developed that will allow ARTC to better maintain and monitor their network of weighbridges using a mobile phone or other device. This is currently underway and will be a significant step forwards in the Strengthening The Core strategy.
"I'm thrilled for the team to see the outcomes of this work. Collectively to design & build our future Integration platform, working through over 30 technical choices, really sets us up for future success. This initiative really has set a benchmark for an approach which we can use into the future." **Andrew Simpson, Applications & Business Intelligence Manager, ARTC.**

Turning Recycled Plastics into Railway Sleepers

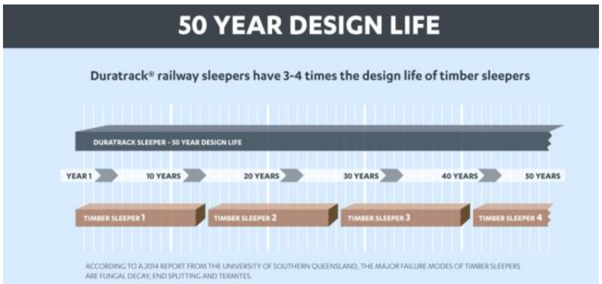
The Victorian government has announced a $1.6 million investment to install a new production line at the Integrated Recycling facility in Mildura. This project will allow Integrated Recycling to process 1,600 more tonnes of plastic and produce up to 35,000 Duratrack plastic railway sleepers.

Integrated Recycling has developed the science to transform waste plastics into a tough and extremely durable material called Polytensilate. Made from about 85% polyethylene and polystyrene plastics, Polytensilate is used to make the Duratrack railway sleeper. Polytensilate products are low in carbon emissions to manufacture and fully recyclable. So, when they reach the end of their 1st, 2nd, or 3rd life, they can be upcycled all over again. Every Kilometre of standard gauge plastic sleeper installed will recycle approximately 90 tonnes of waste plastic.

The sleepers combine plastics previously used for agricultural and industrial purposes and other polyethylene-based plastics with other waste materials to make their products.

The plastic sleeper is currently used across Victoria's railways, including Richmond Station, Wyndham Vale stabling yard and Tottenham Station. Currently the plastic sleeper produced by Duratrack is Type approved for the Metro and V/Line network within Victoria.

With the injection of extra government funding, it is hoped that there will be more opportunities for other network operators to prioritise a plastic sleeper over a more traditional material. The economic and environmental benefits have been proven that this plastic sleeper is a great alternative and is a sensible choice moving forward. Using a plastic sleeper relives the unsustainable pressure on scarce timber resources.



Source: https://www.lilydambrosio.com.au/media-releases/victoria-reinventing-railways-with-recycled-waste/
http://www.integratedrecycling.com.au/railway-sleepers/

New initiatives to further harmonise advanced train control systems

Implementation of train control systems, even standardized, are complex. Greater efficiencies are needed to cater for the rapid evolving technologies while lowering life cycle costs.

New initiatives are emerging to further standardise advanced train control systems towards one same harmonised modular architecture. European consortiums[1] are defining a common reference architecture for Command, Control and Signaling (CCS) to improve deployments and cut life cycle costs.

These initiatives could inspire Australian infrastructure managers currently implementing cab-signaling systems where each infrastructure manager has its own starting point for migration with specific issues. In Australia, upwards and downwards compatibility will be crucial for interoperability between systems to adapt to new technologies and allow smooth train operation while reducing high adaptation costs.

RCA, OCORA and EULYNX (together with ERTMS[2]) programs can provide the basis to infrastructure managers for an architecture with generic functions of the system. Harmonisation of interfaces and a data format are being developed for exchanging engineering data.

- RCA**:** The Reference CCS Architecture defines unambiguous interface definitions leading to an upgradable system with interchangeable components. It is aimed to provide plug & play modular, independent development of components (allowing for technical evolution), and the specification of operators' needs towards the supply industry and the strengthening of this supply industry.
- OCORA**:** Open CCS On-board Reference Architecture focuses on modular on-board command, control and signaling architecture. It develops an open and uniform architecture to cater for future modernizations such as Automatic Train Operation, smart localization and any new train technology which are constantly increasing.
- EULYNX**:** Provides specifications for control trackside assets and standardizes the interfaces around the Interlocking. This includes the conversion of legacy systems for signalling to an industry standard.

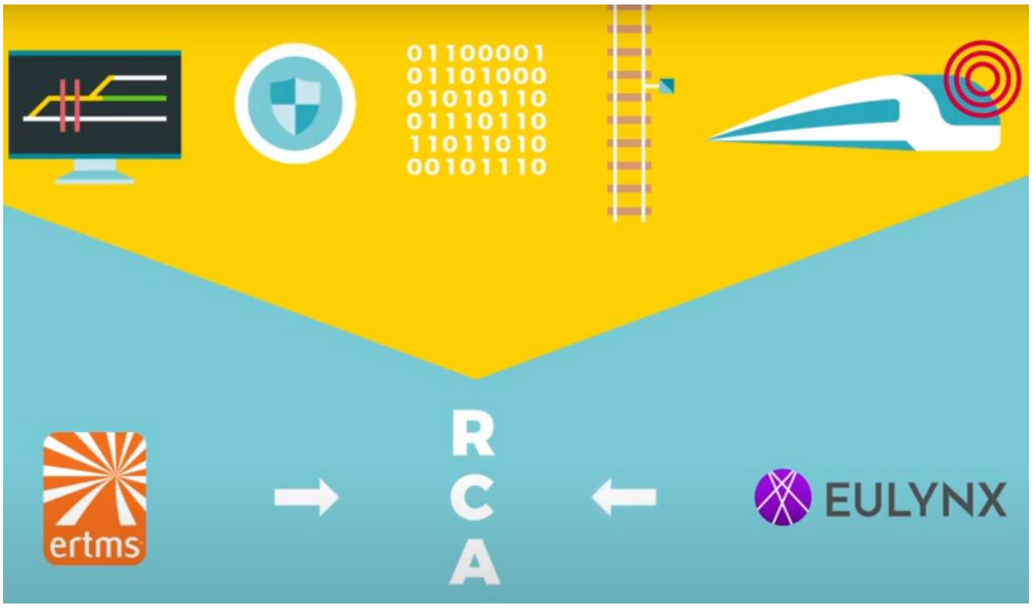


Figure 1 RCS, OCORA, EULYNX and ERTMS initiatives

These initiatives can direct Australian Infrastructure managers and rollingstock operators with robust migration strategies, standardization, and full integration to render adequate return of investment from the large investments currently being made in Australia.

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[1] Members of the ERTMS Users Group (EUG) and EULYNX

[2] Incorporates current European Train Control System specifications with game-changers such as localization and FRMCS.

Thanks for reading

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