RISSB
RAIL INDUSTRY SAFETY AND STANDARDS BOARD

FASTTRACK

THE NEWSLETTER OF THE HORIZONS PROGRAM I NOVEMBER 2019

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

ETCS Standards and the Challenge of Interoperability

Introduction to ETCS Standards
European Train Control System (ETCS) and Computer Based Train Control (CBTC, generally used in metro systems globally) are two prevalent next generation signalling technologies currently being explored in Australia. The key drivers for the transition include, but are not limited to, improved:

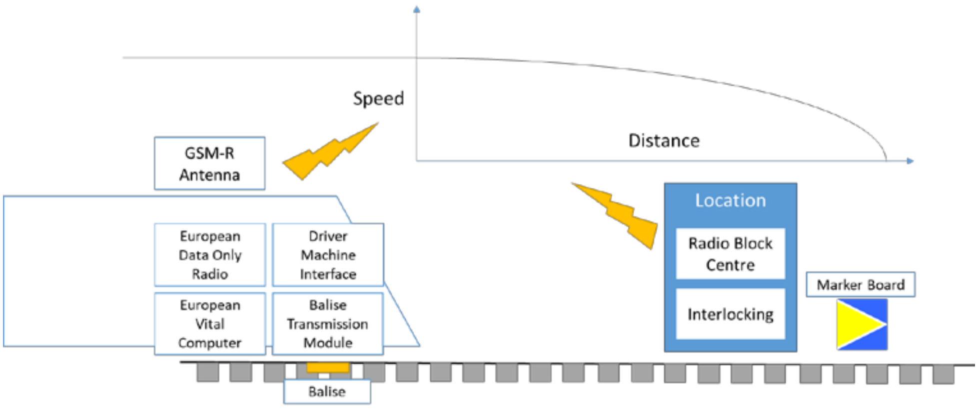
- Safety
- Reliable capacity (more than 24 tph per direction of dedicated track)
- Network management ability.

Standards for ETCS are specified in the Control Command and Signalling Technical Specifications for Interoperability (CCS-TSI) and are part of a wider system of European Rail Traffic Management System (ERTMS) standards co-developed by the European Union Association of Railways (ERA) and industry. Where ETCS only refers to signalling and control elements, ERTMS also includes standards for a European Traffic Management Layer and GSM-R (radio communications).

ERA specifies the following ERTMS Levels, commonly referred to as 'ETCS Levels'.

- **Level 1** – Automatic Train Protection as an overlay of line side signals to enforce speed limits and signal aspects
- **Level 2** – In-Cab Signalling, using radio communications to provide location-based movement authorities in-cab, enabling the removal of lineside signals (more detail below)
- **Level 3** – Moving block sections enabling the removal of conventional train detection and train integrity systems, i.e. axle counters or track circuits

Innovations in current technologies has led to multiple organisations exploring the implementation of Level 2. A simplified operational concept is shown on the next page.



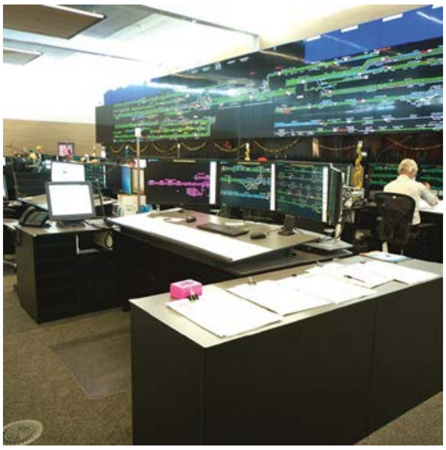
- A route is requested from a control system and validated as safe by the interlocking. Train vacancy and integrity detection are maintained using axle counters or track circuits (not shown).
- Once deemed as safe, the train receives a movement authority from the Radio Block Centre via radio communications directly to a screen in the cab allowing the train to proceed up to a marker board.
- On approach to the marker board, the on-board system limits the speed of the train to a curve based on the pre-determined braking characteristics of the train. Balises on the track support the on-board system by providing the accurate location to the train.

Interoperability
A key principle for the effective implementation of ETCS Level 2 is interoperability; which can be defined as the ability of systems to operate in conjunction with one another. The standards for ETCS Level 2 facilitate interoperability by enabling multiple on-board and infrastructure technology systems from different suppliers to be technically compatible. This is particularly relevant in Europe where a single rolling stock may be required to traverse a myriad of national boundaries each with different stand-alone systems and rules.

Despite the existence of standards for ETCS, 'plug-and-play' interoperability of systems cannot be assumed. Innovative integration, collaboration, and the management of interface risks is required to ensure successful implementation. Some potential interface risks include:

- Specific network requirements driving deviations from standards
- Differing interpretations of standards and client requirements between equipment suppliers
- Differing versions (or baselines) of ETCS
- It is only through managing these risks effectively that future signalling technologies will be able to be sufficiently integrated to yield the required performance benefits on a network, state, and perhaps even national scale.

Future of Train Control



With so many new exciting rail technologies being explored in Australia, the way Train Control is performed will begin to change. Train Control centres have the potential to transform and merge into Integrated Public Transport Hubs combining heavy rail, light rail, buses, metros and ferries. This has the potential to create seamless connections and hassle-free transfer between all modes of transport.

Here are a few ideas of what we may see in the future control centre:

- Universal train control will become a thing of the past with automatic route setting being introduced alongside a new train movement control and monitoring system known as European Train Control System (ETCS) and High Capacity Signalling that works on block train movements.

- Electronic Train Control diagrams will be introduced that are able to plot and route trains automatically through feedback from monitoring systems. This system will respond to delays in real time optimising movements to minimise timetable disruptions.

- The role of a Train Controller will evolve, no longer being signalmen and actively controlling but becoming a skilled incident manager. The role would encompass monitoring and reviewing train movements, maintaining the ability to override the system in degraded modes and ensuring the resolution of incidents is achieved in a safe and efficient manner.

- Protection officers and track workers will request work though a Track Access System which will be a digital "Work On Track" request form that sends through to specific control board track access requirements. ETCS and the Electronic Train Control diagram are able to automatically reject or accept work on track requests taking into account rail traffic movements.

- If the control system was to detect an abnormality on the network, for example, a track fault which prevents the normal Proceed Authority from being available, controllers would have the ability to send Alternative Proceed Authorities directly to specific Train Unit numbers instead of a driver from a separate system that can dictate speed and limits of authority.

- The use of Drones will be more prominent in rail, providing real time images for security purposes, mapping of network and performing checks of the overhead equipment.

- There will be artificial Intelligence monitoring multiple security cameras and sending alerts to specific trains in the areas.

- Trains will have the capacity to automatically inspect the track while travelling at normal speeds that can send through a message to the Infrastructure Maintenance Managers informing exact location and further specifics of the faults found on the network.

- Rolling stock monitoring systems will have the ability to connect to the control centre. Fault detection on units will report in real time but maintenance staff will be provided with the ability to remotely access the rollingstock management systems correcting faults or adjusting running parameters.

Maximising Rail Utilisation in Track

On heavy haul railways, wear to the head of the rail is often the predominant mode of failure over fatigue and corrosion, especially on curves.

Overall wear to the rail head is a combination of side and vertical wear of the rail head with the latter typically the determining factor to predicting optimal renewal dates. Rail wear limits are based on the section capacity of the rail and varies based on axle load, curve radii and rail hardness.

In order to maximise the utilisation and life of the rail without compromising safety, it is important to understand where on the curve maximum wear typically occurs, how to trend and measure rail head section loss and when to optimally re-rail. In sharp curves, rail wear can vary through its length and anecdotally, the exit of the curve for loaded traffic will wear the fastest. This can be the limiting factor governing expiry and as associated re-rail execution date.

When monitoring rail as it approaches end of usable life, mechanical measurements are seldom accurate enough to guarantee wear limits are not breached. Mechanical methods of measurements, such as the Uni-Gauge (see figure 1 below) are used in most cases when rail is being inspected as per scheduled inspections to supplement remote condition monitoring.

Figure 1 - Uni-Gauge which measures vertical and side wear at specified locations of the rail head

Figure 2. Mini-Prof by Greenwood Engineering Measuring the Rail Head Profile

When the need arises and more precise data is required, alternative measurement methods are often utilised. An example of one such measurement method is the Mini-Prof, manufactured by Greenwood Engineering. This technology can give precise levels of accuracy (down to one thousandth of a square millimetre) of rail head section loss.

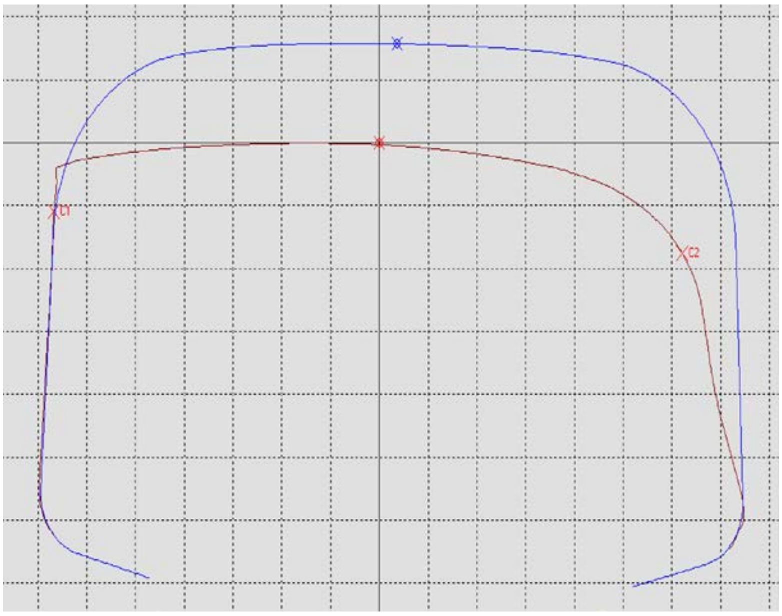


Figure 3. Mini-Prof Software Screenshot Showing Table and Side Wear – the red profile is the in-field condition vs the AS60 profile in blue

The Mini-Prof is magnetically mounted to the head of the rail, tight against the inside face and the measuring wheel is rolled slowly across the transverse rail head. This gives the full cross-sectional profile of the rail head and can be used to calculate the worn area of the rail. The transverse profile can also be analysed against the standard profile to determine the wheel-rail contact conditions.

Once the results are available, re-rail execution dates can be refined to maximise asset depending on the hardness of the rail, this is due to the relationship of yield strength and material hardness. Softer rail steels will have higher wear rates than premium rail grades, therefore, premium grade rail steels are installed in higher wearing environments.

The Future of Monitoring Track Stability in Rail

The technological advances of recent years are beginning to see usage in most aspects of the rail industry. One of the more exciting aspects is remote condition monitoring. Seeing the majority of its use in the manufacturing industry for fixed plant operations, we are beginning to see developments in rail, predominately in the signaling and points operation space. But what about track stability?

Current methods of measuring are labour intensive and time consuming, particularly with congested networks and decreasing track availability. For such a vital aspect of track reliability it seems a bit backwards to still be using string lines and plum bobs when remote condition monitoring technology is available.

Two major indications of track stability is creep and curve alignment. Creep being the measurement of rail into and out of sections denoted with creep monuments (typically km pegs). Curve alignment is a measure of how the curve is currently sitting to a design offset to TCM (track control mark).

Over time and due to a myriad of causes, rail will move longitudinally (creep). This presents problems for track stability when that movement is restricted by fixed assets such as bridges and turnouts. These areas become bunching points and pose a large risk to networks if incorrectly managed.

Curves also have a tendency to move through a natural progression throughout the seasons, often pulling in over winter and out through summer as the internal forces change with the temperature ranges. What often occurs, more so in heavy haul, is long heavy trains attempt to straighten the curve due to the lateral forces under normal traffic, this in turn shortens the curves increasing the amount of steel within the curve and lowering the SFT (stress free temperature).

To combat some of these issues wireless sensor networks could be developed to provide real time data of track positioning with alert levels set when certain thresholds are met. How this might look would be Laser Displacements sensors fitted to tight radius curves at TCM locations giving accurate offsets at set frequencies. With enough data gathered railways would be able to determine what was an expected level of seasonal movement to what is creating track stability risk.

Another opportunity would be utilising a wireless displacement measurement system attached to creep monuments and the rail providing longitudinal rail movements over set frequencies. This would provide creep data in high risk locations and provide data for future track stability and restressing works prior to the onset of summer.

Setting the receivers to operate at determined frequencies would prolong battery life, reducing maintenance costs and track time required to maintain the sensors. Wireless operation allows remote monitoring further reducing maintenance costs and assists in the shift from compliance-based management systems to preventative and risk-based maintenance processes.

This type of system, due to costs, would not be achievable across networks totally but would provide a solution to key high risk areas where repeat stability problems occur such as steep grades, tight radius curves, bridges and other structures.

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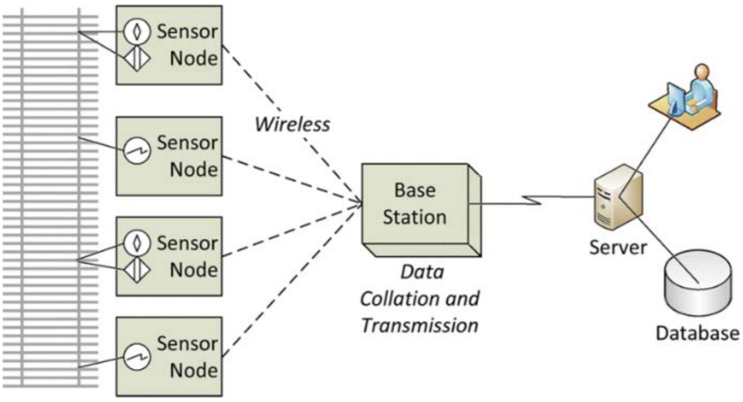


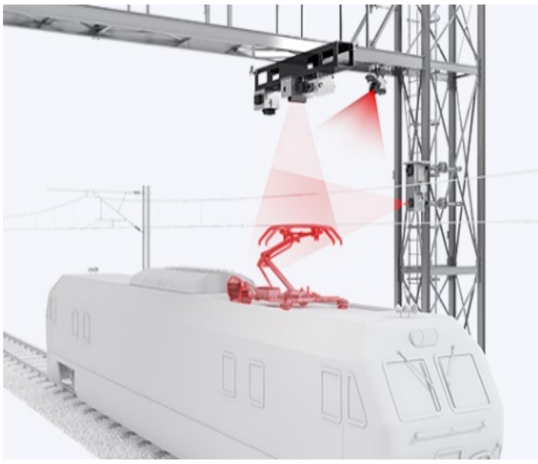
Source :Wireless Sensor Networks for Condition Monitoring in the Railway Industry: A Survey

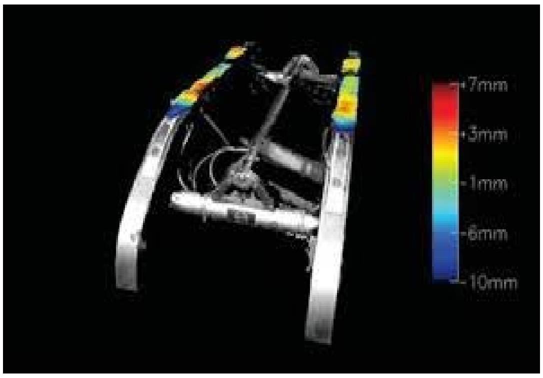
Wayside Automatic Pantograph Monitoring System

Challenge
In an Overhead Wiring system, it is undeniable how important it is to maintain a consistent and smooth interface between a pantograph and the overhead conductor. A damaged pantograph has the potential to cause an entanglement of the overhead wiring, which can lead to severe service disruptions and high repair costs.

Electrical arcs are one of the key factors that lead to a damaged pantograph. Electrical arcs are extremely hot and cause heat damage to the pantograph. Other causes of damage to a pantograph are; increased wear due to poor staggering of the overhead conductor, as well as chipping and cracking of the carbon strips.

Assisting the condition of a pantograph is typically done with an elevated inspection of a train during routine maintenance.





Solution
An automatic pantograph monitoring system is a three-dimensional scanning device that is designed to alert a rail operator of potential damage to a pantograph. The system also provides condition monitoring to assist asset maintainers on pantographs that are reaching their operational limits.

When a train passes an automatic pantograph monitoring system, several cameras captures a shot of a pantograph. Some pantograph monitoring systems can capture images with trains traveling with speeds up to 300 km/h.

Imagine processing software is used to reconstruct the train pantograph in a three dimensional model to determine its overall condition.

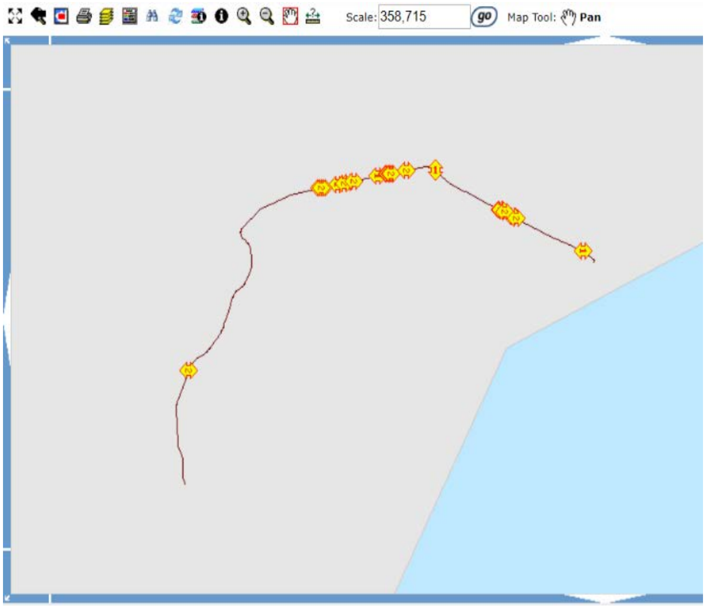
Benefits
An Automatic Pantograph Monitoring System can provide information on:
- Amount of carbon wear and chipping
- Bent or damaged pantograph horns
- Assess the level or roll, pitch and yaw
- Classify the material of the contact strips
- Measure the uplift of a passing pantograph
- Alert a network operator if a pantograph is outside of its normal operational limits
- Pantograph health trend with data prediction on end of operational life

Remote Condition Monitoring

Across Australia's regional and remote railways, there remains a heavy reliance upon manual, manned track inspections to monitor infrastructure. Whilst this is a tried and tested method that remains largely unchanged in recent years, the ever-developing technological landscape is creating potential to streamline and improve inspection processes. One of these advancements that has become increasingly popular is remote condition monitoring. Remote condition monitoring allows for a constant, unmanned assessment of the track which can support manual inspections under certain conditions. This becomes especially important to lines that cover long and remote distances, and heavily trafficked lines where constant inspection routines and intervals are not practical. An example of such a technology is the ENSCO Vehicle/Track Interaction Monitoring system (V/TI).

The V/TI system comprises primarily of a central control box, and four sensors to be mounted on the locomotive. These sensors are used to effectively monitor the interactions between rollingstock and track, measuring the resultant forces. Measurements are broken down into five characteristics, each representing different possible defects:

- Carbody Vertical – Long length vertical track anomalies, impacting ride quality.
- Carbody Lateral – Lateral carbody throws common at bridge abutments and turnouts.
- Truck Lateral – A sign rollingstock maintenance is likely required.
- Axle Vertical – Short length vertical wheel/rail impacts, often associated with crushed heads, wheel burns or loose joints.
- Mid-Chord Offset – Vertical defects where the track lacks support, i.e. joints and mudholes.



Example V/TI defects geographically plot

The readings from the system are then sent via the cellular network, with roof mounted aerials, before being received and compared against a series of predetermined limits. The end result is accessible via the V/TI web portal, where the data and any defect-level events are both graphically presented on a map, and tabulated for easier interpretation.

Thanks for reading

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