The Overland Team: Project A

Interoperability Report

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RISSB Horizons 5.0 2023

1. Executive Summary

Interoperability within the rail network is an urgent challenge in Australia, primarily due to the variation in systems and protocols across different states. Recognising the imperative for a cohesive and efficient rail network, Australia's Infrastructure & Transport Ministers have endorsed crucial reforms. These reforms seek to establish a concise set of high-impact interoperability standards vital for achieving nationwide safety and productivity improvements. The focus is on performance-driven standards emphasising digital train technology, standardising on-board interfaces for drivers and crew, and streamlining rollingstock approvals.

"…codify a small number of high-impact interoperability standards required to achieve nation-wide safety and productivity benefits. The standards will be performance-based with a priority focus on digital train technology, a single on-board interface for drivers and crew and streamlining rollingstock approvals."[1]

Three key areas have been pinpointed as essential in enhancing interoperability:

1. Signalling Systems: Standardising signalling systems is fundamental for compatibility and ensuring uninterrupted movement of trains across state borders. This alignment not only enhances safety but also operational efficiency.
2. Train Control System Integration: Integration of train control systems is critical for seamless operations as trains traverse state borders. Establishing a common interface for the efficient exchange of vital information between varying systems is imperative.
3. Rolling stock approvals: The establishment of standardised procurement standards and procedures for rolling stock is necessary to guarantee uniformity and facilitate interoperability.

In addition, a distinct aspect that requires attention is the interoperability between passenger and freight services. Different operational requirements and priorities for passenger and freight trains can create challenges. Streamlining scheduling, capacity management, and communication between passenger and freight services are critical maximising the efficiency of the entire rail network.

Moreover, the socio-economic impacts of enhanced rail interoperability are profound. Improving interoperability results in more efficient transportation, which can lead to lower costs for consumers and businesses. Enhanced connectivity through rail can boost economic development, especially in regional areas, by creating access to new markets and employment opportunities. Moreover, a more efficient and interconnected rail network can contribute to environmental sustainability by offering a greener alternative to road transportation, thus helping reduce carbon emissions.

For effective prioritisation, it is essential to consider signalling standardisation, train control integration, rolling stock approvals, and together uniformity in rules and procedures, along with passenger vs. freight interoperability and socio-economic impacts. A cost-benefit analysis can be an invaluable tool in this prioritisation process.

By rigorously addressing these areas, Australia's rail network can anticipate significant improvements in interoperability, culminating in enhanced efficiency and safety. Furthermore, this establishes the foundation for a sustainable rail network with a skilled workforce, adept in harnessing technological advancements and addressing the dynamic demands or rail transportation in the future.

National cabinet is tackling the country's rail system, in an attempt to finally end the tangled web of trains, rules and other components that has left Australia with 11 different signalling and control systems across 29 networks.
Rail interoperability was one of eight federation reforms which the cabinet has chosen to focus on.[2]

1. ITMM communique 9 June 2023 - FINAL with minor amendments (infrastructure.gov.au)
2. National cabinet seeks to align rail systems, end scourge of multiple gauges and fragmented networks (afr.com)

2. Introduction

The purpose of this report is to address the task provided by RISSB to Horizon 5.0 ‘Project A’ groups. The task is to outline which activities The Overland team believe should be prioritised to improve rail interoperability in Australia. This report is provided as part of the RISSB Horizon 5.0 program and contains supporting information for the presentation to be given by “The Overland” team at the Horizon program Sydney Forum at UTS Pyrmont on 25-26 July 2023.

This report explores areas identified as ‘critical pain points’ (ITMM Communique Friday 9 December) for the rail industry for the NRAP, and is separated into sections based on these 6 areas:

- identifying the best way to codify national standards to make rail more competitive
- aligning train control and signalling technology on the Australian east coast
- reducing the burden on drivers, crew, and maintenance workers
- streamlining rolling stock approval regimes
- identifying the pathways for digital skills required in the next five years.
- decarbonising transport

2.1 Definition of Interoperability

This report is taking a broad definition of rail interoperability. This can best be summarised as “the ability of things in the rail sector to work together”. While this definition differs from the definition given in AS 7666, we believe the AS 7666 definition of interoperability is unnecessarily complicated.

The definition we have chosen is much broader than some typical definitions found during researching this topic. For example, one definition is a RISSB paper (RISSB and Palazzirail NFRI overview and discussion paper Jan 2022) defined interoperable to mean “Each train fleet can operate over the required network(s) with only one onboard system for network control purposes.” This definition is not the definition adopted by this report.

Some peculiarities found with the definition of interoperability, was that AS 7450 defines what interoperability is not:

- “Interoperability” is not equivalent to “sameness” (AS 7450)
- … “interoperability” is not the same as “interchangeability” (AS 7450)

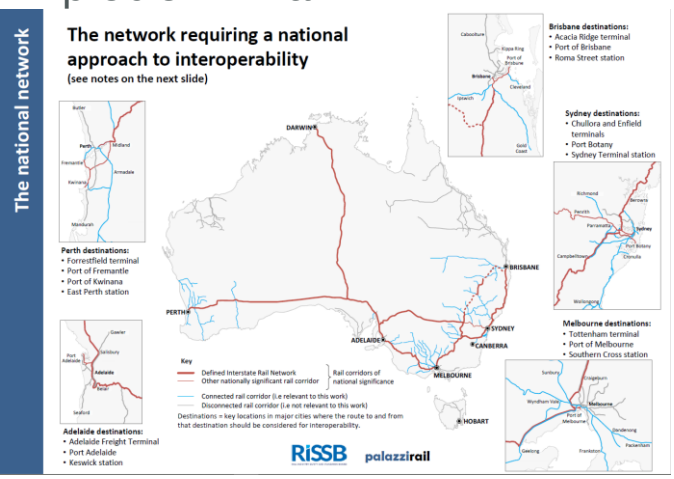
Statements such as these in an Australian Standard hint that the idea of interoperability may have many different definitions depending on who the audience is. The difficulty defining interoperability is the main reason for the broad definition adopted by this report.

One nuance that may not be immediately obvious is that rail interoperability does not require only 1 way of doing something. For example, interoperability does not require only 1 radio system, or only 1 track gauge. The goal of obtaining only 1 radio system or track gauge exists within the realm of harmonisation, not interoperability. In seeking to improve interoperability, the goal of harmonization cannot be ignored, but harmonisation is just one pathway to improving interoperability.

2.2 Report Methodology

Each area identified in the ITMM Communique (Friday 9 December 2022) was investigated by one or two Overland team members and reviewed by a third team member. The most critical objective from each area was then compared using a cost benefit analysis. The outcome of the cost benefit analysis determined the interoperability objectives that ‘The Overland’ team believe should be highest priority for Australia.

2.3 Why is interoperability a problem in rail?



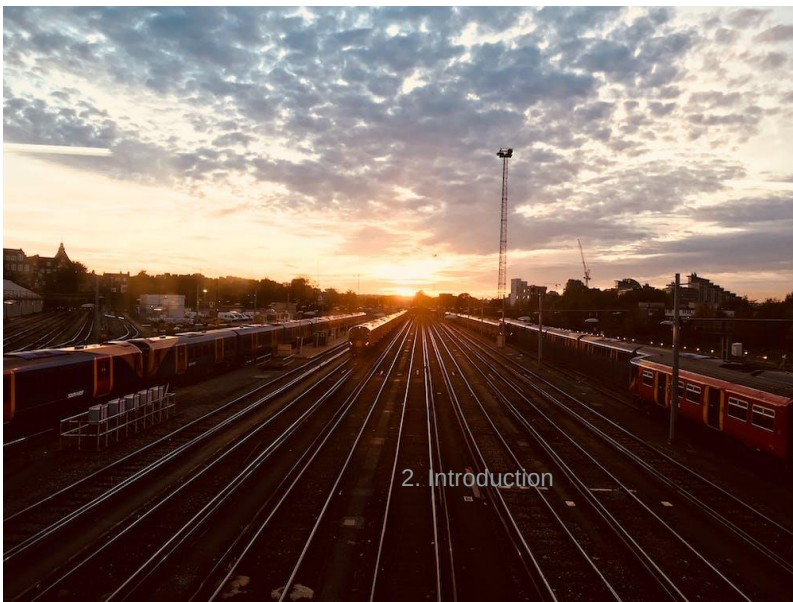
Australia's rail network[3]

Interoperability in rail refers to the ability of different rail systems, networks, and components to seamlessly communicate, interact, and work together. In Australia, interoperability has been a challenge for several reasons:

1. **Fragmented Network**: Australia's rail network is operated by multiple organizations and jurisdictions, leading to a fragmented system. Each operator has different systems, technologies, and protocols in place, making interoperability complex.
2. **Old infrastructure**: The rail infrastructure in Australia has evolved over time, resulting in a mix of old and new systems. Legacy infrastructure often lacks compatibility with modern technologies, making integration and interoperability more difficult.
3. **Diverse Operating Standards**: Different states and territories in Australia have their own sets of operating standards, rules, and regulations. These variations in operational practices and procedures hinder seamless interoperability when trains cross borders or operate across different regions.
4. **Rolling stock variability:** The variability in the rolling stock, especially between passenger and freight rains, can create interoperability challenges. Passenger trains generally require different specifications and features (such as comfort, speed, and accessibility) compared to freight trains which are designed for carrying heavy loads over long distance.
5. **Crew training and regulations:** Differences in operating procedures and regulations between passenger and freight operations can create challenge for crews, especially in cases where they need to operate or coordinate across different systems or regions.
6. **Capacity and scheduling conflicts:** Passenger and freight rains often have different priorities and scheduling requirements. Passenger services usually need to maintain a strict timetable, whereas freight services might operate on more flexible schedules. This difference can create conflicts, especially on shared tracks, affecting interoperability.
7. **Economic interests and competition:** Sometimes the economic interests of different rail operators, especially between freight and passenger services, might not align. This misalignment can create reluctance among operators to collaborate and invest in interoperability efforts, especially if they feel it might give a competitive advantage to rivals.
8. **Geographical and environmental challenges:** Australia's diverse geography and climate conditions mean that trains operating in different regions might need to be equipped to handle different environmental conditions. This diversity can cause additional complexity when trying to achieve interoperability.

2.4 Abbreviations

Abbreviation	Meaning
ARTC	Australian Rail Track Corporation
ATC	Automatic Train Control
ATMS	Advanced Train Management System
ATO	Automatic Train Operation
ATP	Automatic Train Protection
CAN	Conditions Affecting Network
CBI	Computer-based interlocking
CBTC	Communications-Based Train Control
DMI	Driver Machine Interface
DS	Digital Systems
EBI	Emergency Brake Intervention
EoA	End of Authority
ETCS	European Train Control System
FRNSW	Fire and Rescue New South Wales
GSM-R	Global System for Mobile Communications - Railway
IoT	Internet of Things
ITMM	Commonwealth Infrastructure and Transport Ministers Meeting
LEU	The Lineside Electronic Unit
NFRI	National Framework for Rail Interoperability
NRAP	National Rail Action Plan
NSCC	National Service and Communications Centre
NTC	National Transport Commission
NTCS	National Train Communications System
ONRSR	Office of the National Rail Safety Regulator
PPE	Personal Protective Equipment
QR	Queensland Rail
RIM	Rail Infrastructure Manager
RISSB	Rail Industry Safety Standards Board
ROC	Rail Operations Centre
RSNL	Rail safety national law
SARC	Safety access the rail corridor
SBI	Service Brake Intervention
TAFE	Technical and Further Education
TfNSW	Transport for New South Wales
VOBC	Vehicle on-board controller-computer
WET	Working in electrified territory
ZC	Zone Controller



3. Train Control

Train control interoperability is a crucial aspect of rail operations in Australia. The lack of interoperability between different state railway systems poses challenges that need to be addressed for seamless movement of trains across state borders. Several initiatives and challenges related to train control interoperability have been identified in the Australian context.

One notable initiative is the Interoperability training drills conducted by the Sydney Trains Rail Emergency Response Unit in collaboration with FRNSW (Fire and Rescue New South Wales). These drills, including train lift and rescue exercises, have been done since 2017 to enhance interoperability and emergency response capabilities.

The NTC says there are 11 different signalling and train control systems in use in Australia.

Another significant effort is the TfNSW SmartRail program, which focuses on the development and deployment of Automated Systems across SmartRail areas. The deployment of Automated Systems aims to address asset replacement and capacity requirements across the network, enabling interoperability for freight and regional passenger trains.

To achieve train control interoperability, various challenges must be addressed. One challenge is the use of multiple rail gauges, different signalling systems, rolling stock, and safe working arrangements across Australia. These differences create complexities and require costly workarounds that hinder economic efficiency.

The procurement of modern train control systems in the coming years also requires seamless integration and interface compatibility along the eastern seaboard. Ensuring that these systems can effectively operate and communicate with each other is vital for achieving interoperability.

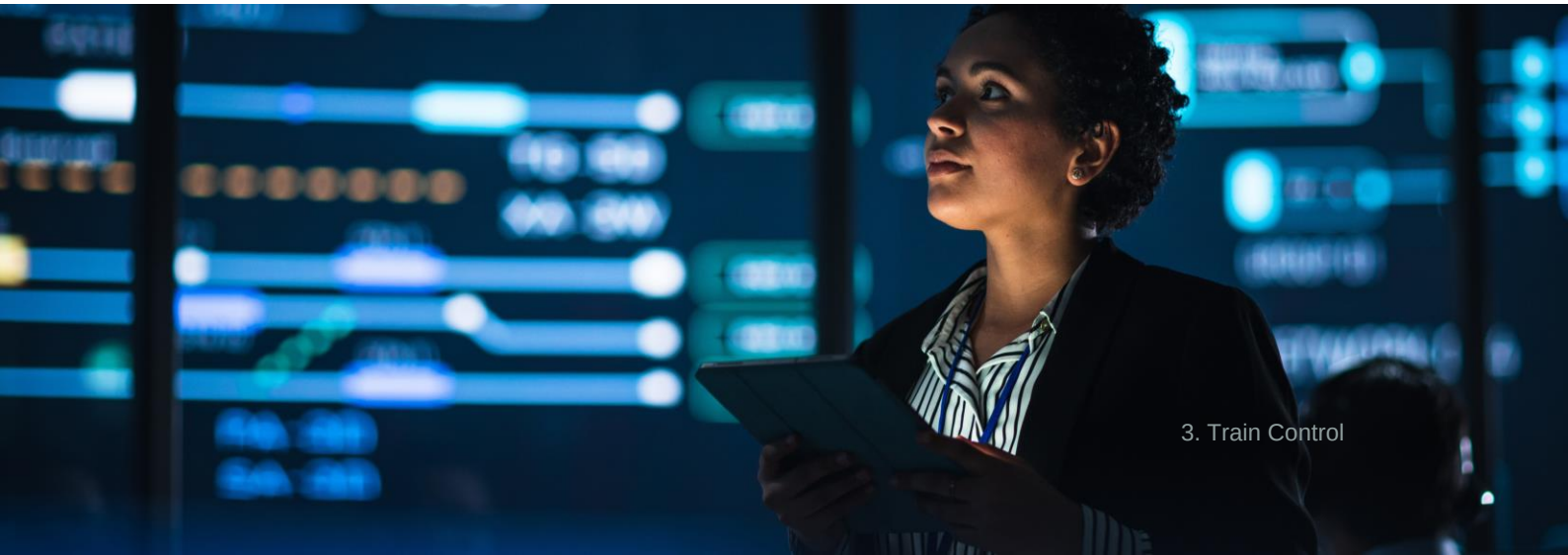
The National Transport Commission (NTC) recognizes the importance of nationally recognized skills in improving rail interoperability. The NTC aims to gather data and conduct analysis to identify the specific job-ready digital skills needed across the rail sector. This data will inform the development of training programs aligned with the pace of digital transformation in rail, facilitating the adoption of consistent, portable, and internationally recognized advanced digital rail skills across Australia.

The National Rail Interoperability Framework, established by the NTC, seeks to connect the fragmented national rail network into a cohesive system. Standardisation of signalling systems, integration of train control systems, communication system compatibility, standardisation of train control rules and procedures, and comprehensive training and education programs are key areas addressed by the framework to achieve interoperability.

The NTC said the lack of interoperability meant trains were fitted with multiple sets of equipment, and complex and expensive track-side equipment was duplicated.

The harmonisation of train control system through interoperability has wide-ranging socio-economic impacts. For passenger services, it means more reliable and timely services, which can boost public transport patronage, reduce road congestion, and contribute to environmental sustainability. For freight services, interoperability can enhance the efficiency of supply chains, reduce transit times, and lower costs. This, in turn, can make Australian goods more competitive and stimulate economic growth. Additionally, investment in interoperability can create jobs and stimulate technological innovation within the rail industry.

Addressing these challenges and implementing the initiatives mentioned above will improve rail interoperability in Australia. Seamless movement of trains across state borders, enhanced safety, increased capacity, improved operational efficiency, and national productivity gains are some of the expected benefits of achieving train control interoperability.



4. Signalling

Network	1Rail (Tarcoola to Darwin)	Arc Infrastructure	ARTC	Aurizon	Brisbane	Melbourne	NSW regional	Perth	Queensland regional	Sydney
Arc Infra.										
ARTC	ATMS – *ATMS*	ATMS – *ATMS*								
Aurizon										
Brisbane			ATMS – ETCS L2	ETCS L2 – ETCS L2						
Melbourne			ATMS – *ETCS L2*							
NSW regional			ATMS – eTOW							
Perth		*CBTC – ATMS*	*CBTC –* ATMS							
Queensland regional				ETCS L2 - *undecided*	ETCS L2 - *undecided*					
Sydney		ETCS L2 - *ATMS*	ATMS – ETCS L2		ETCS L2 – ETCS L2	ETCS L2 – *ETCS L2*	ETCS L2 – eTOW	ETCS L2 – *CBTC*		
Victoria regional			ATMS – eTOW			eTOW – *ETCS L2*				

Note: Items shown in strikethrough reflect existing operational interfaces that may be eliminated if network segregation works in Perth proceed.

Interactions between systems – the need for interoperability[4]

4.1 CBTC vs. ETCS

The interoperability issue in Australia is most critical at state borders as states have different procedures, standards, approvals, operators, and technology. Operability of signalling across the different Australian states with CBTC, ATMS, and ETCS systems are used in different states in Australia.

4.1.1 Communications-Based Train Control (CBTC)

CBTC is a moving block system that enables high-capacity trains, precise positioning, and continuous train communications. It uses beacons and onboard sensors for train position estimation and Wi-Fi for communication. Components include an integrated network, wayside components, and onboard components.

4.1.2 European Train Control System (ETCS)

ETCS is an interoperable and fail-safe solution that supervises train movement by speed limit. ETCS Level 1 (L1) relies on lineside signals and track circuits or axle clearance detection. ETCS Level 2 (L2) eliminates lineside signals and uses GSM-R for track-to-train communication. ETCS Level 3 (L3) is still in development and employs a moving block system without track circuits. For freight trains ETCS is considered a better option as it utilises track detection devices on the field to detect train integrity and it more cost-effective.

4.2 In-Cab Signalling Driver Training

There are different communications and signalling systems requirements between states and across networks. As a result, in-cab systems need to cater for these different approaches, adding cost and complexity to driver training and mobility. A failure to address this will continue to hamper innovation and make it harder to adopt automation on networks where it is not currently in place. In-cab signalling is a technology that displays information from trackside signals and other relevant information to train drivers inside the rollingstock cab. Driver training for in-cab signalling is crucial to ensure that drivers understand how to interpret the signals and operate the rollingstock safely. To improve the interoperability of in-cab signalling in Australia, the following would need to be implemented:

- Standardisation of training programs: The training programs should be designs to teach the same principles and procedures, regardless of the type of in-cab signalling system used. This would require close collaboration between the training providers and the system manufacturers to ensure that the training programs are compatible with different systems.
- Standardisation of simulators: In-cab signalling training is often done using simulators that replicate the in-cab signalling system. Standardisation of simulators is essential to ensure that the training is consistent and that drivers can practice using different types of in-cab signalling systems. This would require collaboration between the simulator manufacturers and the system manufacturers to ensure that the simulators are compatible with different systems.
- Testing and certification: The in-cab signalling training programs and simulators should be rigorously tested and certified to ensure that they meet the required standards and specifications for interoperability. Testing should include interoperability testing with different types of in-cab signalling systems to ensure that the training is effective for all systems.

4. RISSB Interoperability Impact Plan – Addressing issues from the proposed introduction of new train control systems v1.0 February 2021

4.3 Advanced Train Management System (ATMS)

In terms of signalling, the ARTC manages the national standard (AS 7666, Train Protection and Control) for train control systems, known as the Advanced Train Management System (ATMS). This system is designed to be interoperable across different rail networks and technologies, allowing trains to move seamlessly between different regions and networks. Additionally, the ARTC works closely with state and territory governments to ensure that different signalling systems are compatible with each other. The system uses satellite-based technology to provide a single, national platform for train control, allowing for better coordination between different networks and operators.

Interoperability of ATMS in Australia would require ensuring that different systems can communicate and exchange data seamlessly. ATMS is a highly advanced signalling system that manages train traffic, safety, and security. It is essential for the system to operate without any issues and provide accurate information to the train operators, maintainers, and other stakeholders. ATMS does not use balises. Here are some ways that interoperability can be achieved for an ATMS across Australia:

1. Standardisation of protocols and interfaces: The first step to achieving interoperability is standardisation of communication protocols and interfaces. The system should be designed in a way that it can communicate with other systems that use the same or compatible protocols and interfaces. This would require close collaboration between the system designers, manufacturers, and operators to ensure that the protocols and interfaces used are compatible with other systems.

2. Testing and certification: the system should be rigorously tested and certified to ensure that it meets the required standards and specifications. Testing should include interoperability testing with other systems to ensure that it can exchange data and information seamlessly. It should be tested and certified to ensure that it meets the required standards and specifications for interoperability with the NTCS.

3. Compatibility with legacy systems: ATMS should be designed to be compatible with existing legacy systems that are already in use. This would require careful consideration of the different systems in use and designing the ATMS to be able to communicate and interface with these systems.

4. Collaboration with stakeholders: Interoperability requires collaboration between different stakeholders, including system designers, manufacturers, operators, government, and private operators spanning across all states, and regulators. Collaboration should be encouraged to ensure that everyone is working towards the same goal of achieving interoperability.

These included identifying the best mechanism for codifying with the industry a smaller number of critical standards to make rail more competitive; aligning train control and signalling technology on the eastern seaboard; and streamlining rollingstock approvals.

4.4 Integration with National Train Communications System (NTCS)

Another initiative aimed at improving signalling interoperability is the development of the NTCS. This system is designed to provide a standardized communication platform for trains across different networks, improving communication and coordination between trains and the train control centres. It is essential for the system to operate without any issues and provide accurate information to the users.

Similar to ATMS, interoperability can be achieved with NTCS by standardisation of protocols and interfaces to ensure the NTCS and ATMS systems can communicate and exchange data seamlessly. The ATMS should be designed to integrate with the NTCS to ensure that the two systems can work together seamlessly, this would require close collaboration between the system design designers, manufacturers, and operators of both systems to ensure that the integration is smooth and efficient.

5. Operational Crew/Drivers

5.1 System-level aspects and competencies

In the context of interoperability in rail for Australia, the operational crew and drivers play a crucial role. They ensured the smooth and safe operation of trains while adhering to the systems and procedures established by the rail operator. This adherence ensures consistency and standardization across the network.

Furthermore, the operational crew and drivers must be prepared to respond to system-level aspects. This involves understanding how the various systems in place relate data to assets. It is crucial to have a comprehensive understanding of these systems to effectively operate and make informed decisions in real-time situations. Additionally, they must consider legacy systems that may still be in use and understand their implications on interoperability.

Train driver competencies are essential for seamless interoperability in rail operations. Drivers should possess a range of skills and knowledge that encompass both metro and regional operations. They should be capable of operating trains across different states, where operational procedures and regulations may vary. This adaptability ensures the efficient and safe movement of trains throughout the network.

Moreover, route competency plays a vital role in specific corridors, such as the SE Corridor Dandenong in Melbourne Metro. Drivers may need to demonstrate familiarity with these specific routes, including their unique characteristics, infrastructure, and operational procedures. This knowledge enables them to navigate these corridors effectively and manage any procedural requirements specific to those areas. Route knowledge and proficiency are also indispensable, particularly in intricate corridors. For passenger services, the ability of drivers to efficiently navigate through the network translates to shorter travel times and greater reliability, which can encourage the use of public transport and mitigate road traffic. In freight operations, proficiency in route knowledge is crucial for the efficient transportation of goods, especially in high-traffic corridors or those with unique operational requirements.

Furthermore, the roles of operational crew and drivers in freight is paramount in enhancing commerce and economic activity. Proficiency in transitioning goods efficiently across states, with a keen understanding of the diverse systems and procedures, directly influences the supply chain. Punctual deliveries, minimised losses, and efficient logistics make significant positive contributions to the economy.

The competence of the operational crew and drivers significantly affects public perception and confidence in rail transportation. For passenger rail services, enhanced reliability and safety can persuade commuters to choose public transport over personal vehicles, contributing to a greener and more sustainable network. For freight, reliability can make rail a more attractive option for businesses, potentially stimulating more investment in rail infrastructure.

5.2 Digital Systems Train Crew

During the deployment of Digital Systems (DS) in Australia's rail operations, the NSW rail network will operate with both the new and existing signalling environments. This dual signalling landscape will continue until the entire network is upgraded to the ATMS and/or the ETCS L2 across the Rail Infrastructure Management System (RIMS). The Rail Operations Centre (ROC) at the National Service and Communications Centre (NSCC) will adopt new working methods to manage this interface. The transition to ETCS L2 will impact employee competency and learning requirements, necessitating training in new technology, updated Network Rules and Procedures, and local business processes. Future train fleets transitioning between ETCS L2 and other networks or RIMS will require updated signalling processes, with the introduction of an ATMS interoperability solution playing a crucial role. Network Rules and Procedures will be specifically updated for ETCS L2 areas.

NSW TrainLink will need to adjust to these new network rules and procedures, while conventional signalling areas will follow existing rules until the Digital Systems rollout is complete. The onboard system will continuously monitor train speed and intervene if the driver fails to slow down adequately near the End of Authority (EoA), using Service Brake Intervention (SBI) or Emergency Brake Intervention (EBI). The Driver Machine Interface (DMI) will display a notification of the intervention applied. To grant permission to pass an EoA in ETCS L2 areas, a new process involving written orders will be developed, potentially replacing, or modifying existing procedures, including managing degraded modes such as Conditions Affecting Network (CAN) Warning. Drivers and guards will need to be familiar with the new written orders.

6. Maintenance Worker

6.1 Access to Site

Accessing the rail corridor or rolling stock workshops is the first step of being a maintenance worker. To access these areas, rail operators require “Safety access the rail corridor (SARC)” training to have been completed. While there is a “nationally recognised” course called “TLIF0020 – Safely access the rail corridor”, Queensland Rail does not accept this, and requires a bridging course. Different states have various SARC courses and different expiry dates as referenced on the SARC course.

The focus on SARC training is required since it is the bare minimum required to enter rail corridors and areas of work. Having a nationally consistent and recognised SARC qualification will assist in interstate workers travelling and visiting work sites. Due to the small size of the WA and Adelaide, the courses are identical, however the issue is that QR and ARTC/V/Line course content are different. This creates confusion, and duplicated effort, requiring staff to attend multiple different SARC courses, even if they already know most of the course content.

In addition to SARC, workers for QR also require “Working in electrified territory (WET)” training. This training is in addition to QR specific SARC training.

These examples highlight the need for a nationally consistent training package to allow workers to access rail sites.

6.2 Competency

While there is a rail safety worker defined in the Rail safety national law (RSNL), this definition doesn’t carry any qualifications. There is a clear need for sub classifications or competencies to be tied to the rail safety worker definition. As it stands, the rail transport operator must determine competency (as per RSNL), which would mean that whenever a worker changes to a different rail transport operator, competency must be re-established by the new operator. Some examples of rail safety work (from ONRSR - Identifying rail safety work under the RSNL) is as broad as:

- Driving trains
- Building trains
- Repairing track
- Testing rail infrastructure
- Certification of rail systems
- Management of passenger safety

The first indicator of a national training product is on the horizon. Recently (early 2023) a RISSB Safely access the rail corridor (SARC) Governance Committee was formed with the goal of “working towards development of national SARC product”. However, on its own, RISSB cannot force operators to adopt or accept the training. This issue highlights another issue in the Australian rail sector, is that most of the standards developed by RISSB are opt-in.

6.3 Clothing

Clothing is as important as training when it comes to maintenance workers, since it dictates whether access to site is possible. There are examples, where the pattern of the high vis striping on shirts is not allowed by certain operators. A specific example is NSW requiring an “X” pattern on the back of a shirt, while VIC does not allow the “X” pattern. Victoria requires a “VIC rail spec vest”, as can be seen below, in front of a level crossing removal work site. Below figures are photos from online retailers (hicraftsafety.com.au) showing the two different products they stock for NSW and VIC.

Worksite safety board showing “VIC rail spec vest” (photo credit: Marcus Wong)

NSW Rail hi vis safety vest (from Sayka)

JB’S hi vis VIC Rail Safety Vest with zip (from Sayka)

6.4 Top issue for maintenance workers

The most important issue affecting maintenance workers is ‘access to site’ requirements, specifically training. While clothing is an access to site requirement (similar to requiring the correct lock colours), these issues of clothing and locks can be easily solved by having spares available, however training requires multiple days delay waiting for training courses to be available, and to complete the training.

Due to the delay that training can have on workers attending site, training is therefore the number 1 issue for maintenance workers in terms of rail interoperability. Specifically, nationally recognised training where workers can obtain training in any state of Australia, and that training is accepted by all Australian rail operators and infrastructure managers.

7. Rollingstock Approvals

The adoption of a unified rollingstock strategy between states will require focus on the several areas to manage interoperability and a simplified approval process. These potential strategies are outlined below. Developing a common procurement framework which includes having common standards, procedures, criteria, and templates for procurement. Common guidelines will assist in tender evaluation, contract management, dispute resolution to name a few. This will allow for consistency through the procurement process, reduce inconsistencies and make it easier for supplier to understand requirements when entering the market. Creating a central procurement body e.g. an agency or department who will manage this on behalf of the states ensuring a wider view of interstate strategy (with a long-term procurement strategy in place) consistency and making sure requirements are met across all states. Collaboration between states to identify interoperability issues and potential solutions and joint procurement initiatives can also help to reduce costs and enable sharing of knowledge across different states.

Engaging with industry can help to improve the efficiency of rolling stock procurement and maintenance. The government can leverage their expertise and resources to improve the quality and reliability of rolling stock and enter different procurement strategies (e.g. Public Private Partnerships).

Another proposed initiative is the development of a national rollingstock database, which would provide a single, centralised source of information about all rollingstock in use across the country. This would help to ensure that rollingstock meets the necessary safety standards and is compatible with different networks. Investment in rolling stock maintenance facilities is crucial for ensuring the smooth operation of rolling stock. This includes upgrades to existing facilities, as well as the development of new facilities to cater to the needs of rolling stock that are used across different states. Adequate investment in these facilities can ensure that rolling stock is well-maintained, reducing the risk of breakdowns and improving the reliability of the network.

Investment in rolling stock maintenance facilities is crucial for ensuring the smooth operation of rolling stock. For passenger services, emphasis should be on amenities and safety, while for freight, focus on cargo handling and efficient logistics is essential. These investments can lead to more reliable networks, increasing the overall productivity and positively impacting the economy through reduced delays and increased consumer satisfaction.

Using common rolling stock technology can be achieved by developing a common set of specifications and standards for rolling stock procurement. This would enable the procurement and maintenance of rolling stock easier, as they would be working with standardised systems and parts. Additionally, the implementation of technologies in the design of rolling stock can improve efficiency and interoperability, these can include:

- Automation systems – which can enable trains to run more smoothly and reduce the risk of accidents caused by human error. Similarly, digitalization can enable real-time tracking of rolling stock, improving scheduling, and reducing delays.
- Signalling compatibility - Being compatible with multiple signalling systems can help to ensure compatibility across different rail networks. This can be achieved by designing systems that can adapt to different signalling requirements.
- Transitioning between electrification systems can improve compatibility across different rail networks. This can be achieved by designing rolling stock that can operate on both electrified and non-electrified sections of the rail network, or by designing rolling stock that can be easily modified to operate on different electrification systems.
- Adjustable suspension systems –which can adjust the height of the floor to match different platform heights and provide interoperability between different networks and infrastructure interfaces.
- Designing rolling stock that is easily adaptable to different climate and weather conditions can improve interoperability across different rail networks. This can be achieved by designing rolling stock that can operate in a wide range of temperatures and weather conditions, ensuring that it can be used across different state borders without issues.

Implementing these strategies, while accounting for the distinct needs of passenger and freight services, will significantly enhance interoperability and streamline the rollingstock approval process. This unified approach will ultimately contribute positively to Australia's socio-economic development by improving rail services and fostering economic efficiencies.

Since federation, rail has run as a series of independent rail networks, often receiving upgrades and new technologies at different times from different suppliers. This has led to a range of critical issues impacting national rail productivity and innovation, such as the use of different gauges, signalling systems, rolling stock and safe working arrangements, differences in how to run trains, manage rail crew and invest in new rolling stock.

8. Digital Skills Pathways

The number of Australian rail jobs relying on digital skills is expected to grow by 54 per cent over the next five years as technology advances and modern signalling and train control systems are introduced.[5]

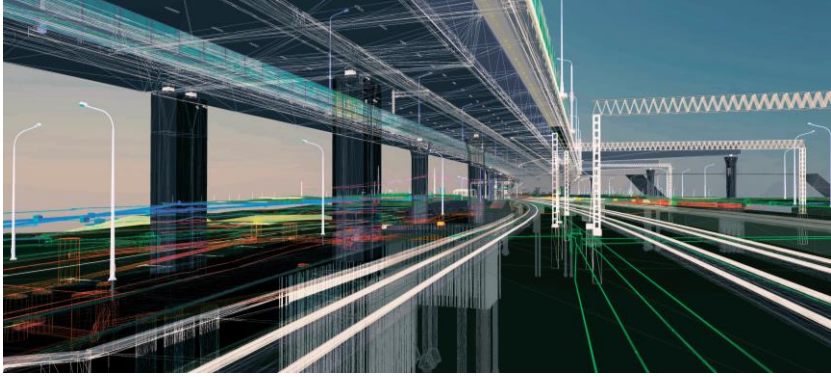
The principal areas of deployment of digital technologies in the rail industry are:

- offering connected railways by providing reliable connectivity for safe, and efficient network
- enhancing customer experience by offering better and added value for customers
- increasing capacity by enhancing reliability, efficiency, and performance
- boosting rail competitiveness by making the most of transport data.

In the next five years, the rail industry in Australia is set to undergo significant transformation as it integrates digital technologies to enhance interoperability. The principal areas of digital technology deployment in the rail industry encompass connected railways, customer experience enhancement, capacity increase, and the utilisation of transport data for competitive advantage. The following pathways are essential for equipping the workforce with the digital skills necessary to drive this transformation:

Identify key digital skills areas: for passenger services, focusing on customer-facing technologies such as mobile applications, ticketing systems, and real-time information system will be crucial. Freight services require skills in logistics optimisation, tracking, and routing technologies. Both sectors benefit from cybersecurity, big data analytics, and IoT.

Collaboration with Universities: Partnering with academic institutions to develop curricula focusing on passenger-centric technologies such as user experience design and customer service analytics will cater to the passenger rail sector. For freight, emphasis on supply chain management and logistics technologies is essential. Such collaborations foster innovation and ensure a skilled workforce that can contribute to socio-economic development.



1. Integration into TAFE courses: integrate digital technology modules within existing TAFE courses. By incorporating cybersecurity, data analytics, IoT, cloud computing, and automation modules into TAFE programs, students can acquire the necessary skills to engage with the digital technologies in the rail industry. This integration enables the current workforce to upskill and adapt to the fast-paced digital transformation.
2. Emphasis on high school education: raise awareness among high school students about the rail industry as a viable and attractive career option, such the as the CSIRO STEM program for primary/high schools. Develop campaigns and initiatives that emphasise digital advancements in the rail industry, career opportunities, and the significance of digital skills in rail operations. This approach aims to inspire the younger generation to consider digital career paths within the rail sector.
3. Development of rollingstock-based courses: investigate the development of rollingstock-based courses at universities, emulating the success of the aerospace programs. Universities can establish specialised courses and degrees focused on rolling stock engineering, design, and maintenance such as The University of Wollongong Rolling stock program. This approach caters to the specific needs of the rail industry and establishes a pathway for individuals keen on this specialised field.
4. Promote the Rail industry internationally: intensify efforts to promote the Australian rail industry internationally as a significant employer of skilled workers. Showcase the potential, growth prospects, and digital advancements of the industry to attract global talent. Introduced skilled work visas tailored for rail professionals, enabling international experts to contribute to Australia's rail interoperability objectives.

By strategically addressing these pathways, Australia can ensure that its rail industry is equipped with a skilled workforce that can effectively harness digital technologies for the enhancement of rail interoperability, safety, and efficiency. By focusing on these digital pathways and skills with a clear distinction between passenger and freight rail services, Australia can optimise the benefits of rail interoperability. This targeted approach not only enhances the efficiency and safety of the rail systems but also contributes significantly to the nation's socio-economic develop and global competitiveness in the rail sector.

5. Advancing Digital Skills in Rail | rsh (railskillshub.gov.au)

9. Decarbonisation

Improving rail interoperability and decarbonisation in Australia requires a comprehensive approach involving various strategies and initiatives. Here are some actions that can be taken to enhance rail interoperability and promote decarbonization:

1. Electrification and Renewable Energy: For passenger services, electrification enhances travel experience by reducing noise and increasing reliability, thus fostering increased patronage which is vital for urban areas. For freight, electrification contributes to the reduction of operational costs over time. Both sectors benefit through reduced carbon emissions, which have long-term positive effects on public health and environmental conservation.

2. Network integration and connectivity: improved connectivity for passenger services enhances mobility, supports regional development, and improves accessibility to jobs and services. For freight, efficient network integration ensures seamless transport of goods, which is crucial for industries, agriculture, and overall economic performance.

3. Policy and regulatory framework: A strong framework incentivise greener technologies in both sectors. In passenger transport, this translates to wider societal benefits such as reduced road congestion. In freight, it could mean more competitive exports due to lower transportation costs, positively impacting the national trade business.

4. Collaborative partnerships: Collaboration in passenger rail can lead to innovations that enhance customer experiences, while in freight, it can result in logistical improvements. For communities, partnerships mean a more responsive rail service that can adapt to changing needs and preferences.

5. Investment and funding: investment in passenger rail can spur urban development, improve property values, and create jobs. For freight, investment can mean more reliable and cost-effective supply chains which can lead to economic growth.

6. Data sharing and analytics: for passenger services, this means better-informed planning and operations, leading to enhanced service reliability and user satisfaction. For freight, it can translate to optimal logistics, lowering costs. Socio-economically, data-driven efficiencies in both sectors can contribute to economic competitiveness and quality of life.

7. Targets on achieving decarbonisation: including the local manufacturing of rolling stock not only reduces carbon emissions associated with transportation but also stimulates local economies through job creation. For both passenger and freight, local manufacturing can lead to tailored solutions that address the specific needs of each sector.

By implementing these strategies, Australia can make considerable progress in improving rail interoperability while simultaneously advancing decarbonisation efforts. Such actions will contribute to a more efficient, sustainable, and integrated rail system that supports the country's transportation needs while reducing its carbon footprint. Advancing rail interoperability and decarbonisation in Australia has compound benefits for both passenger and freight services. Socio-economically, these actions support national economic growth, environmental sustainability, and enhance the quality of life for people by providing efficient, sustainable, and integrated transport solutions

“If decarbonisation is the ticket to destination net zero, then rolling stock is the rail pass to reducing and removing carbon dioxide output from the rail sector. “ – 30th November 2021[6]

6. https://www.aurecongroup.com/insights/decarbonisation-rolling-stock-rail

10. Stakeholders' involvement in Interoperability

In achieving interoperability in the rail industry, various stakeholders including governments, suppliers, operators, regulators, unions, and industry bodies need to collaborate and contribute their expertise and resources.

1. Governments:
    i. Funding and investment: provide financial support for the modernisation and standardisation of rail infrastructure and technology
    ii. Policymaking: develop policies that foster interoperability and facilitate coordination between different states and entities
    iii. Facilitating collaboration: acts as a facilitator to bring together various stakeholders to work toward common goals in rail interoperability
2. Suppliers:
    i. Standardise technologies: develop and supply technologies that comply with interoperability standards, ensuring that equipment and systems can be used across different states
    ii. Innovation and R&D: invest in research and development to innovate solutions that address the unique challenges of rail interoperability in Australia
3. Operators:
    i. Implementation: ensure that operations comply with interoperability standards and that personnel are trained to operate across different networks.
    ii. Sharing Best Practices: collaborate with other operators to share best practices to contribute to the development of common operational procedures.
4. Regulators (ONRSR):
    i. Setting standards: develop and enforce standards that ensure compatibility and interoperability across different rail networks
    ii. Monitoring and compliance: monitor rail operations to ensure compliance with interoperability standards, and take corrective actions when non-compliance is detected
5. Unions (RTBU):
    i. Representing workforce: ensure that the interests and welfare of the rail workforce are considered in interoperability initiatives.
    ii. Skill Development: work with operators and educational institutions to develop training programs that equip the workforce with the skills needed to operate in an interoperable environment.

5. Industry bodies:
    i. Advocacy and lobbying: advocate for policies and investments that support rail interoperability.
    ii. Knowledge sharing: facilitate the sharking of knowledge, data, and best practices among stakeholders such as at Conferences i.e. CORE and AusRail.
    iii. Developing guidelines: assist in developing guidelines and standards for interoperability and support members in implementing them

In summary, successful interoperability in the rail industry in Australia necessitates a collaborative and integrated approach involving various stakeholders. Governments should provide the policy framework and funding; suppliers should focus on innovation and compliance with standards; operators should ensure implementation and share best practices; regulators should set and enforce standards; unions should represent the workforce and ensure skill development, and industry bodies should advocate, share knowledge, and assist in developing guidelines. All these stakeholders need to work in tandem to create an efficient and interoperable rail system that benefits both the economy and society

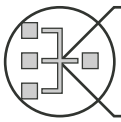
11. Prioritisation

11.1 Prioritisation List

To conduct a cost-benefit analysis and determine the prioritisation for rail interoperability in Australia, we need to consider the various aspects mentioned in the provided text. Here is a breakdown of the areas that need to be addressed for rail interoperability and their potential costs and benefits, ordered in prioritisation:

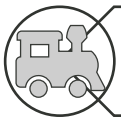
1. Standardisation of signalling systems

- Cost: Significant investments in upgrading and retrofitting existing systems, enhancing digital training systems and facilities, developing communication protocols
- Benefit: Improving safety and efficiency, reducing confusion, and fewer errors when trains cross borders, seamless movement of trains across state borders.



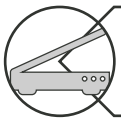
2. Integration of train control systems

- Cost: Substantial investments in software development, digital systems and system integration
- Benefit: Seamless operation and information exchange between different state railway networks. Efficient coordination and management of trains across state borders. Effective communication between drivers.



3. Common procurement standards and procedures for rollingstock

- Cost: Standardisation efforts, staff/driver training, system development, infrastructure, and ongoing management
- Benefit: Improvement consistency. Streamlined procurement process. Cost savings. Reduced disputes. Wider interstate strategy. Consistency in procurement. Knowledge sharing.

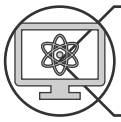


4. Digital Skills Development

- Cost: Investment in developing digital skills for the rail workforce
- Benefit: Enhancing connectivity. Improving customer experience. Increasing capacity. Leveraging transport data. Safer and more efficient networks. Improving reliability. Boosting competitiveness

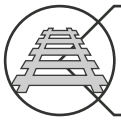
5. Communication Systems

- Cost: Investments in upgrading infrastructure and implementing compatible communication protocols
- Benefit: Effective communication between train drivers, control centres, and signalling systems, enhancing safety and efficient train operations.



6. Training and Education

- Cost: Investments in curriculum development, training facilities and resources
- Benefit: Familiarity with new systems. Reducing risk of errors. Improving safety. Efficiency.

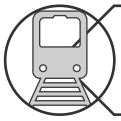


7. Standardisation of train control rules and procedures

- Cost: Coordination and collaboration between authorities and operators
- Benefit: Reducing confusion and errors. Consistent and efficient operations across different state railway networks

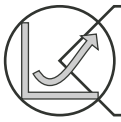
8. Decarbonisation Strategies

- Cost: Investment in electrification infrastructure, renewable energy generation
- Benefit: Reducinf greenhouse gas emissions. Sustainability. Improvinf rail efficiency. Reducinf emissions. Improvinf overall system performance.



9. In-cab signalling driver training

- Cost: Collaboration between training providers and system manufacturers
- Benefit: Effective interpretation of signals. Safe operation of rollingstock. Improving interoperability and safety

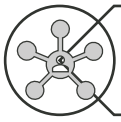


10. Advanced Train Management System (ATMS)

- Cost: Investments in system design, testing, and integration
- Benefit: Effective interpretation of signals. Safe operation of rollingstock. Improving interoperability and safety

11. Operational crew/drivers

- Cost: Investments in curriculum development and training resources
- Benefit: Safe and efficient operation of trains. Interoperability. Consistent standard.



12. National Train Communications System (NTCS)

- Cost: Collaboration between system designers, manufacturers, and operators.
- Benefit: Improving communication and coordination. Enhancing safety and efficiency in rail operations

13. Maintenance worker

- Cost: Coordination and collaboration between rail operators and authorities
- Benefit: Interstate worker mobility. Improving interoperability in maintenance operations

11.2 Cost-benefit analysis

In developing prioritisation for the measures listed, a systematic approach that considers the relative importance, urgency, interdependencies. The cost-benefit analysis to develop the prioritisation is an essential tool used in this context to evaluate each measure by quantifying and comparing the costs and benefits. Below is a synthesis of how prioritisation has been developed and cost-benefit analysis completed for the measures:

1. Immediate needs and safety: priority should be given to measure that address immediate needs and have a direct impact on safety. For example, standardisation of signalling systems, and integration of train control systems are fundamental for ensuring the safe and efficient operation of the railways. The analysis for these measures would focus on the long-term benefits of improved safety and efficiency, weighed against the initial investment in upgrading and integrating systems.
2. Operational efficiency and consistency: the next level of prioritisation should be given to measures that improve operational efficiency and consistency, such as common procurement standards and procedures for rolling stock, and standardisation of train control rules and procedures. For these, the analysis has included analysis of the cost savings achieved through streamlined processes and the value of consistency in operations, compared to the costs of standardisation efforts.
3. Human capital development and skill enhancement: human capital is an essential resource in the rail industry, and measures such as digital skills development, training and education and development for operational crew/drivers are vital. These have been considered prioritised based on the urgency and relevance of skills required. The analysis considers the long-term value of having a highly skilled workforce in terms of improved service quality, reduced errors, and increased competitiveness against the costs of curriculum development and training.
4. Communication and coordination: measures like communication systems and national train communications system (NTCS) are crucial for improving coordination in rail operations. The analysis of these measures has focused on the benefits of enhanced safety and efficiency against the costs of upgrading infrastructure and implementing compatible communication protocols.
5. Sustainability and future proofing: as the rail industry evolves, sustainability becomes crucial. Decarbonisation strategies should be prioritised considering their long-term impact on the environment and system efficiency. The analysis has assessed the long-term environmental and efficiency gains against the initial investment costs in electrification and renewable energy generation.
6. Specialised training and systems: measures such as in-cab signalling training and advanced train management system (ATMS) can be prioritised based on specific needs and technological advancements. The analysis has focused on the safety and interoperability improvements they bring in comparison to the costs involved in collaboration and system development.
7. Interstate mobility and maintenance: lastly maintenance worker mobility and interoperability in maintenance operations have been prioritised based on interstate needs and requirements. The analysis should analyse the benefits of interstate worker mobility in maintenance against the costs of coordination and collaboration.

In conclusion, the prioritisation should be dynamic, adaptable, and consider various factors including safety, efficiency, human capital, sustainability, communication, and specialised needs. The cost-benefit analysis has comprehensively weighed the long-term benefits against the associated costs for each measure.

Passengers and freight will move seamlessly and safely between major cities and regions as a modern, integrated, and productive rail network that works as one interoperable system.

12. Call to Action

The development of a robust, safer, and more efficient rail network in Australia requires concerted effort from all of us. Both freight and passenger rail services, each with their unique needs and challenges, must be catered to holistically. Your involvement, collaboration, and commitment can make a significant difference in transforming these ambitions into reality.

Standardisation of signalling systems is an integral part of this initiative. While significant investment is needed to upgrade existing systems, enhance digital training facilities, and develop communication protocols, the benefits are manifold. For the freight sector, this implies a more reliable service that can significantly boost our economic stability. For passenger services, this translates into enhanced safety and punctuality. Your support can help us realise these benefits.

Equally important is the integration of train control systems. This requires substantial investment in software development and system integration. Yet, the seamless operation across state borders and efficient coordination of trains that this will enable is invaluable. Both freight and passenger services stand to benefit greatly from this enhanced coordination.

We also need to rally behind common procurement standards. Standardisation of procurement processes and infrastructure development can lead to significant cost savings. For the freight sector, this can mean streamlined operations and increased efficiency. For passenger services, it could allow for reinvestment in amenities to improve passenger comfort. Your advocacy in this regard can be pivotal.

Prioritising digital skills development within our rail workforce is also vital. With your support, we can leverage transport data more effectively, leading to safer and more efficient networks. This has far-reaching implications, potentially reducing operational costs for freight services, and increasing reliability for passenger services, ultimately contributing to a higher quality of life for communities.

The need for upgraded communication systems is evident. By investing in infrastructure and implementing compatible communication protocols, we can enhance safety and efficient train operations. This plays a crucial role in fostering a harmonious co-existence between freight and passenger services on shared tracks.

Emphasising the importance of training and education, we seek your support in curriculum development and resource allocation. This is essential to reducing the risk of errors and improving safety and efficiency in both freight and passenger services.

Your endorsement for the standardisation of train control rules and procedures, decarbonisation of the rail network, and the development of the ATMS is also vital. Each of these initiatives has socio-economic implications that extend far beyond the rail network itself, including enhanced economic growth, job opportunities, and improved quality of life.

In advocating for in-cab signalling driver training, investing in operational crew/drivers, supporting the NTCS and standing behind our maintenance workers, we are contributing to a broader vision of improved connectivity and accessibility in Australia.

In conclusion, your action, be it in the form of investment, advocacy, or collaboration, can drive this transformative change in our rail network. Together, let's work towards a unified, efficient, and sustainable rail network that boosts Australia's economic growth and social development. Your voice and support are invaluable. Let's move forward together on the right track!

“Improving interoperability of the national rail network will mean more people will be employed, more manufacturing will be local, and more passenger and freight services will travel by rail.” - Infrastructure, Transport, Regional Development and Local Government Minister Catherine King[7]

7. https://minister.infrastructure.gov.au/c-king/media-release/once-generation-opportunity-get-australian-rail-back-track