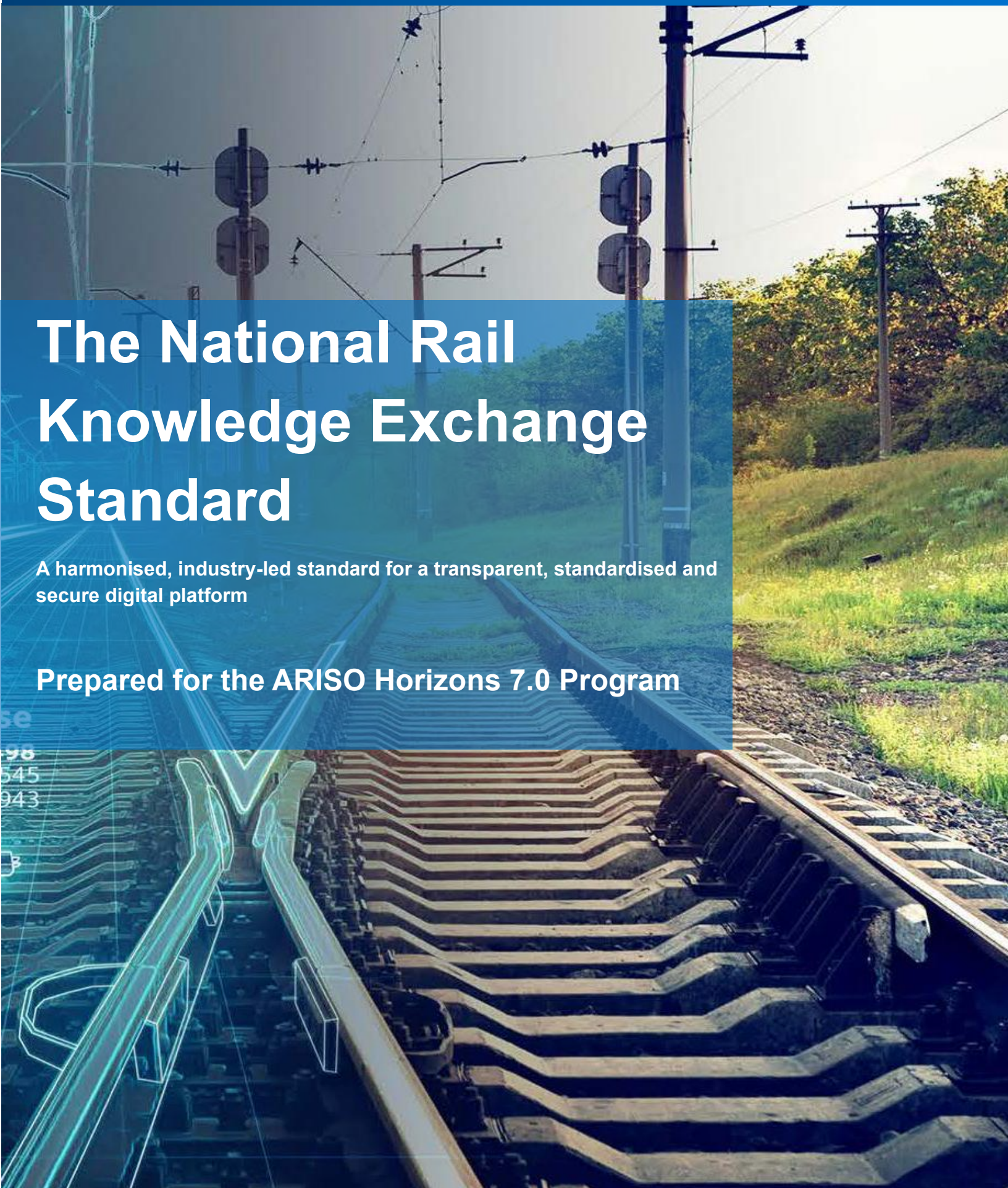
INTERLINK AUS



The National Rail Knowledge Exchange Standard

A harmonised, industry-led standard for a transparent, standardised and secure digital platform

Prepared for the ARISO Horizons 7.0 Program

Contents

1 Executive Summary

The Australian rail network has evolved as a series of independent systems, resulting in fragmentation across standards, infrastructure, technologies and operational practices. This creates inefficiencies for operators moving across network boundaries.

In October 2025, The GHD Harmonisation of Rail Standards Research Report identified that a key barrier to harmonisation is limited information sharing and collaboration across the various Australian railway networks, reinforcing the need for visibility and sharing of digital data across the sector to support harmonisation.

In August 2025, Australia's Transport Ministers announced ARISO's new role to support the development of mandatory standards, lead harmonised standards and support industry where local standards are required. ARISO has progressed working on a prioritisation methodology framework for harmonised standards. ARISO for the Horizon 7 program has grouped participants into teams and given a Project theme to identify or suggest a non-mandatory standard or code of practice that, when implemented nationally, would result in significant benefits to the rail industry. This report is prepared by team *Interlink Aus*.

The National Rail Knowledge Exchange (NRKE) standard is a Tier 2 non-mandatory standard which proposes for the sharing of information between authorized railway network maintainers, operators, infrastructure managers and asset owners using GS1 standards, via an NRKE Platform.

The NRKE seeks to directly increase information sharing and collaboration through the establishment of foundational digital layer and a secure digital platform to enable true national interoperability by transforming fragmented asset data into a standardised and traceable system. The key benefits of this system are increased productivity, sustainability, and long-term industry harmonisation.

The NRKE builds on Project i-Trace, initiated by the rail industry and the Australian Rail Association (ARA) and developed using ISO certified GS1 global data standards. Since 2016, Project i-Trace has engaged with industry to support and encourage adoption of a GS1 compliant Asset Identification and Traceability framework which aims to standardize asset information.[1] This standardised asset information serves as the common digital language for the NRKE implementation.

[1] GS1 in Europe, GS1 Standard enabling the EU digital product passport, January 2025, <https://gs1.eu/wp-content/uploads/2025/04/GS1-Standards-Enabling-DPP-V2.2-April-2025.pdf>

While GS1 standards have been implemented internally by a number of suppliers both internationally and locally in Australia, there is significant opportunity to further leverage the benefits of GS1 standards if it is implemented as the digital language for data sharing between railway network maintainers, operators, infrastructure managers and asset owners.

The implementation of this standard supports existing initiatives including the National Rail Action Plan (NRAP),[2] harmonisation across the National Network for Interoperability (NNI), and the Australian Rail Industry Standard Organisation's (ARISO) 2026 Work Plan. [3]

[2] National Transport Commission, *National Rail Action Plan*, November 2025, <https://www.ntc.gov.au/sites/default/files/assets/files/National-Rail-Action-Plan.pdf>
[3] RISSB, *RISSB's Work Plan 2025-2026*, December 2025, <https://www.ariso.org.au/wp-content/uploads/2025/08/RISSB-202526-Work-Plan.pdf>

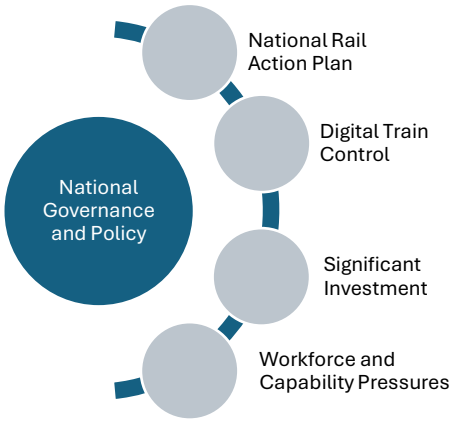
2 Interlink Aus

Interlink Aus is a research collective of young, aspiring rail professionals from both private and public sectors across Australia (Yarra Trams, Transport for NSW, TorrensConnect, Systra, Queensland Rail & GM Rail). Formed in October 2025, the group brings together not only a varied range of technical expertise, but also a drive to collaborate and innovate towards a forward-looking rail network. Beyond its core members, Interlink Aus has forged connections with industry leaders from the Australasian Railway Association, PT&I, GS1 & Sydney Trains. Together, constituents are united by a shared vision and desire to shape a harmonised future in Australian rail.

3 Background

3.1 National Governance and policy

Australia's transport ministers, through National Cabinet, have made rail interoperability one of eight national priorities to help build a more productive economy.



3.1.1 National Rail Action Plan (NRAP)

- Australia is currently in the delivery phase of the National Rail Action Plan, the most significant reform program in rail governance in over a century[4]
- The National Rail Action Plan (NRAP) helps the Australian rail industry operate as one national system and brings works together to create a modern, interoperable rail system that can meet the needs of our growing cities, regions and ports.

[4] National Transport Commission, *National Rail Action Plan*, November 2025, <https://www.ntc.gov.au/sites/default/files/assets/files/National-Rail-Action-Plan.pdf>

3.1.2 Digital Train Control: Single National Pathway Agreed

- In August 2025, Infrastructure and Transport Ministers agreed that the European Train Control System (ETCS) will be the single national digital train control technology on the NNI.[5]

3.1.3 Significant Investment

- More than $150 billion is being invested nationally in rail upgrades, resilience works, and digital systems. Recent budgets alone allocated over $1 billion to modernising critical interstate infrastructure and flood resilience.[6]

3.1.4 Workforce and Capability Pressures

- The national rail network will see significant investment and transition toward digitally enabled operations, requiring substantial skilled and interoperable resourcing and capability to support the development and implementation of these works.[7]

3.1.5 Australian Rail Industry Standards Organisation

The Australian Rail Industry Standard Organisation (ARISO) 2026 Work Plan delivers 32 projects that support productivity, safety and sustainability across Australia's rail industry. The current area of priority is in relation to harmonisation and interoperability.[8]

4 Problem Definition

4.1 Problem Statement

The Australian rail network is functionally connected but structurally fragmented, comprising approximately 18 principal networks (up to 29 including sub-networks) that have evolved independently across jurisdictions.

This has resulted in:

- Multiple signalling and train control systems (approximately 11 nationally)

[5] National Transport Commission, *Historic step towards a unified national rail system*, August 2025, <https://www.ntc.gov.au/news/historic-step-towards-unified-national-rail-system>
[6] National Transport Commission, *National Rail Action Plan overview,* National Transport Commission, 2026, <https://www.ntc.gov.au/transport-reform/national-rail-action-plan>
[7] See n.6
[8] Australian Rail Industry Standards Organisation (ARISO). *ARISO Work Plan 2025–2026*, 2025, <https://www.ariso.org.au/wp-content/uploads/2025/08/RISSB-202526-Work-Plan.pdf>

- Inconsistent operating rules and workforce competencies
- Divergent engineering standards and assurance processes

As recognised by the NTC and ONRSR, this fragmentation represents a systemic constraint on operations, productivity, safety and interoperability, particularly for interstate and cross-border operations.

One of the key causes of the existing fragmentation is lack of visibility and transparency across interfaces on the NNI and lack of consultation and collaboration between railway networks.

Fragmentation of information across Australian rail networks and operators

- The ARA and NTC identify fragmentation as a core barrier to interoperability, with inconsistent access to technical information, localised practices and siloed supplier knowledge.
- Current environments see repeated designs, assurance, type-approval and human-factors analysis by different operators working on similar assets or digital systems.

Lack of visibility and transparency across interfaces on the NNI

- The Office of National Rail Safety Regulator highlights signalling control systems, safe working rules, and operational changes as areas requiring better cross-operator consultation and information exchange.
- Despite progress in management systems, information remains unevenly shared across the sector.

4.2 Industry Insights

4.2.1 Harmonisation of Rail Standards Report

The Australian Rail Industry Standards Organisation (formally Rail Industry Safety Standards Board) commissioned GHD Advisory to develop a research paper to provide deeper insights into what is preventing the adoption of existing international and Australian standards, to achieve national harmonisation.

In October 2024 the paper was published with the data determining Australia's rail system operates as a collection of disconnected networks, constraining the adoption of common standards and creating avoidable cost, complexity and inefficiency.

Industry feedback found that:

- Addressing this fragmentation requires coordinated national alignment. The National Rail Action Plan identifies a national approach to critical standards as central to this reform.
- The Australian rail network has inconsistent approaches to asset identification, classification, and data exchange across jurisdictions.

Additionally, the report also provided key findings on the scale of the challenge, drivers of fragmentation, system level impacts of fragmentation and the associated implications for ARISO and Industry Partners. These findings are summarised in the following sub-sections.

4.2.2 Scale of the Challenge

The extent of fragmentation represents a material system-wide issue:

29 networks, multiple operators' diverse technical systems

An estimated $155 billion in planned rail investment over the next 15 years

An estimated $1.85 billion in estimated lost savings over the past decade

Rollingstock procurement subject to an approximate 30% cost premium due to bespoke requirements.

This fragmentation creates a significant and avoidable cost burden across industry and government, with benefits of harmonisation increasing in proportion to scale of investment.[9]

4.2.3 Drivers of Fragmentation

These challenges are driven by a combination of structural, commercial, governance and behavioural factors.

- Structural: Legacy systems and network-specific operating environments limit interoperability.

[9] GHD Advisory, *Harmonisation of rail standards research report*, October 2024, Australasian Railway Association, National Transport Commission, ONRIC, & Rail Industry Safety and Standards Board, <https://ara.net.au/wp-content/uploads/Harmonisation-of-Standards-Research-Project-Report.pdf>

- Commercial: Fragmented procurement approaches and specifications reduce economies of scale.
- Governance: Lack of coordinated national accountability for harmonisation outcomes.
- Regulatory: Limited use of mandatory standards reduces enforceability of adoption.
- Incentives & Risk: High transition costs and operational risks discourage change.

The core constraint is not the availability of standards, but misalignment across incentives, governance and system conditions required for adoption.

4.2.4 System-Level Impacts

These drivers translate directly into system-wide impacts including:

- Increased capital cost due to bespoke design and procurement
- Duplication in testing, assurance and approvals processes
- Reduced interoperability and asset utilisation
- Increased lifecycle complexity and maintenance cost
- Slower delivery and higher program risk

Fragmentation directly reduces cost efficiency, delivery performance and network productivity.

4.2.5 Implications for ARISO and Industry Partners

These findings indicate that value will not be realised through standards definition alone.

For ARISO and industry stakeholders, this requires a shift toward enabling adoption at scale, supported by:

- Coordinated governance and accountability mechanisms
- Regulatory and incentive frameworks to drive uptake
- Alignment of procurement and specification approaches
- Implementation of interoperable data and digital standards (e.g. GS1 / i-Trace)
- Reduction of cost and risk barriers to transition

5 Research

The project team has undertaken research through publicly available information and interviews with wider industry stakeholders to understand current harmonisation initiatives particularly in relation to digital data standards and platforms any benefits and barriers associated with them.

Below is the summary of various initiatives, strategies and approaches referred to by the Interlink Aus while developing NRKE.

5.1 Australian Digital Strategies

Current State – National

Despite considerable efforts in adopting technology and data systems, efforts to date have been siloed and mainly driven from a bottom-up perspective. This is evident through a lack of digital policies, programs and funding associated with both national and state based digital uptake. The table below demonstrates the state of Australia's application of digital strategies by state governments.

Digital Strategies	WA	SA	VIC	TAS	NSW	ACT	QLD	NT
Digital Twins								
Internet of Things								
Geospatial								
BIM								

Green – Strategy in place Orange – Partial Capability/Early Strategy Red – Nil or limited capability/strategy yet to be defined

Leadership is necessary to establish a clear strategy or framework for success such that a government or country can realise value from their investment. A key indicator of potential success is evidence of strategic frameworks.[10]

5.2 National Rail Safety Data Strategy

The project team consulted with representatives from ONRSR who were part of the team that developed and implemented the National Rail Safety Data Strategy for standardising safety incidents and safety performance reporting across by the accredited Rail Transport Organisation across the country.

[10] Standards Australia, *Digital Twin White Paper*, March 2023, <https://www.standards.org.au/documents/digital-twin-white-paper>

It has long been established that Australia's rail incident reporting originally evolved from state-based regulators, leading to inconsistent, excessive, and often data collected that was larger in volume but lacked information for the regulator and/or the rail industry to learn and improve from in generating better safety outcomes.

The structural elements introduced to efficiently implement the strategy included:

- Framework– explaining the "why" and overall concepts of the strategy.
- Reporting requirements – simple, readable, decision-based guidance for operators and industry participants.
- Data submission requirements – technical data specification for IT systems to collate occurrences, ontology and other metadata.
- Business glossary – nationally standardised definitions for all terms used to standardise language used for Rail Safety Data.

This has now been implemented by ONRSR for Operators to use for over 3 years now and ONRSR have realised below benefits:

- Clear reduction in reporting volume
- Improved data consistency and usability
- Stronger understanding of risk and consequences
- Unexpected benefit: More coordination and collaboration between Rail Infrastructure Managers (RIMs) and Rolling Stock Operators(RSOs)

This informed us that for implementation of any initiative a clear strategy with enabling structural pillars such as framework, common language and specifications promotes the industry adoption for realising the harmonisation benefits.

5.3 National Level Crossing Portal (NLXP)

The National Level Crossing Portal (NLXP) is a nationally coordinated digital platform developed by the Office of the National Rail Safety Regulator on behalf of the National Level Crossing Safety Committee (NLCSC). Introduced in 2021, the portal provides authorised stakeholders with access to a common national non-commercial dataset relating to level crossing safety, characteristics, occurrences, ownership, traffic volumes, and site conditions across Australia. Developed through collaboration between rail infrastructure managers, road authorities, and regulators, the portal consolidates the level crossing data into a standardised and accessible national database.

The success of NLXP demonstrates the value of nationally harmonised information sharing in improving safety, transparency, and decision-making across the rail industry.

Similar to how NLXP provides a common platform for level crossing data, the proposed National Rail Knowledge Exchange (NRKE) seeks to establish a framework for sharing asset information, component data, and rail knowledge across Australian rail networks using GS1 standards as the common digital language.[11]

5.4 International Digital Strategies

Current State – International

As a global leader, the European Commission has already developed its strategy for data. The strategy acknowledges that digital technologies have transformed the economic and societal aspects of member countries and that data is at the centre of that transformation. An outcome of the strategy is the creation of Common European Data Spaces[12] and National Access Points (NAPs)[13] that ensure the availability of more data for use in social and commercial applications. The concept has been formed with:

- An open system for the participation of all organisations;
- Secure and privacy-preserving infrastructure;
- Datex II as the data exchange standard;
- Fair, transparent, proportionate and non-discriminatory access rules;
- Compliance with the European Union's General Data Protection Regulation (GDPR) data privacy and security law for consumer and personal data protection; and
- The availability for holders to make their data available for reuse for free or against compensation.

The NAPs are mandatory under the EU Intelligent Transport Systems (ITS) directives and the obligation to collate and supply data to the NAPs is supported by underlying regulatory framework including several of the European Commission delegated regulations. These EU initiatives are expected to enable the realisation of significant data-driven innovation.

[11] National Level Crossing Portal. (n.d.), Retrieved June 2026, <https://nlxp.com.au/>
[12] Common European data spaces (n.d.), Accessed February 2026, <https://digital-strategy.ec.europa.eu/en/policies/data-spaces>
[13] European Commission, *National Access Points*, October 2025, <https://transport.ec.europa.eu/transport-themes/smart-mobility/road/its-directive-and-action-plan/national-access-points_en>

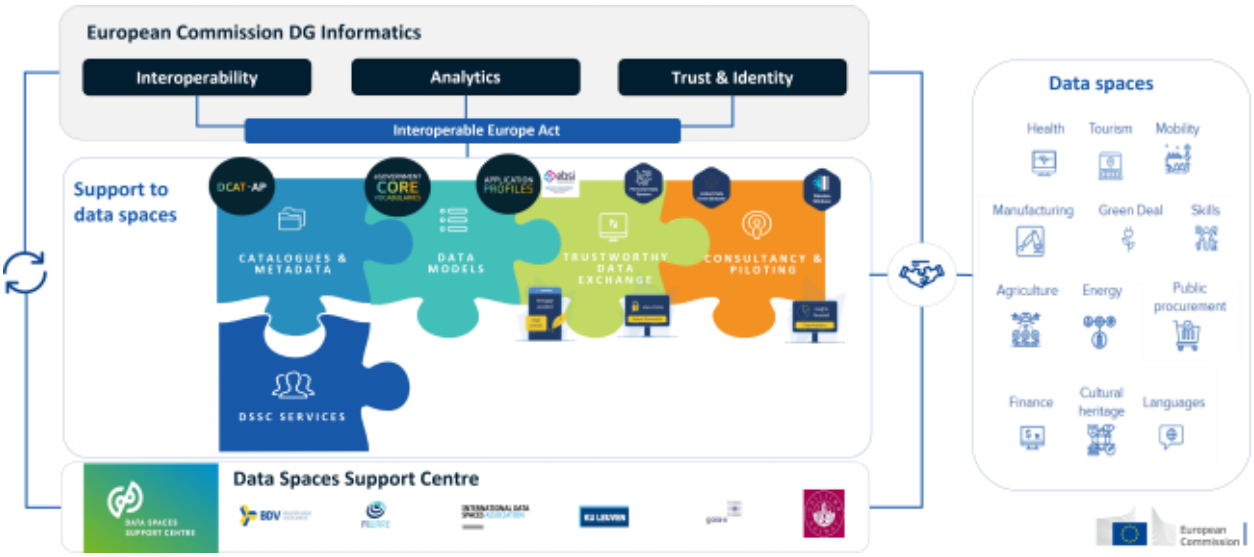


Figure 1 – An overview of the European Commission's digital landscape

5.5 European Regulatory Approach

The common regulatory approach in European Standards begins from Interoperability Directive Essential Requirements which are in turn supported by Technical Specifications for Interoperability (TSIs), mandated Standards directly referenced in TSIs, Common Safety Methods (CSMs), harmonised European Standards (EN) as well as other standards and codes of practice.

Secure sharing of data is Europe is supported by legislation and regulations such as the Data Governance Act, The Data Act and the General Data Protection Regulation.

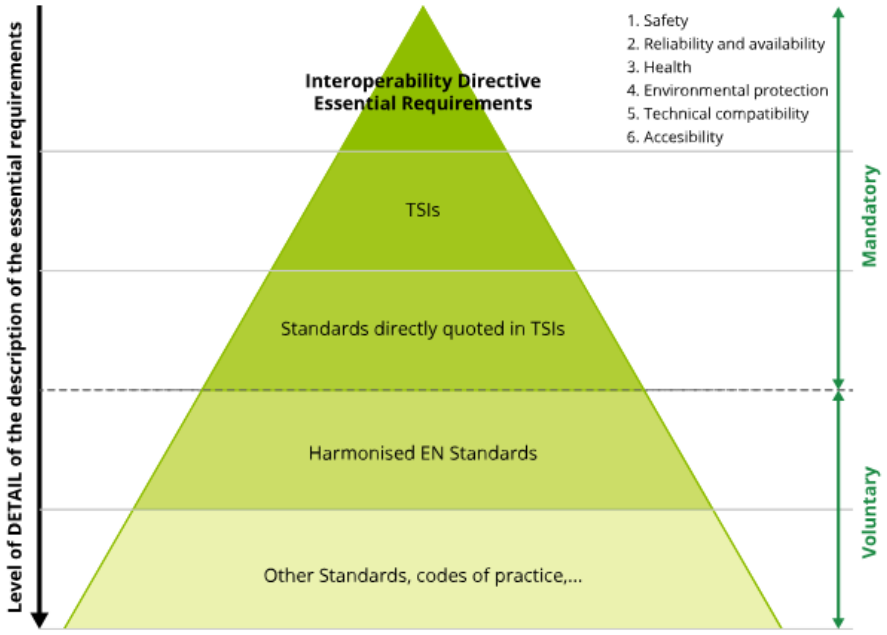


Figure 2 – the hierarchy of mandatory and voluntary requirements in European Standards

6 Solution

6.1 National Rail Knowledge Exchange

The National Rail Knowledge Exchange Standard (NRKE) seeks to implement a Tier 2, non-mandatory standard to provide a foundational digital layer, enabling true national interoperability by transforming fragmented asset data into a connected, traceable, and standardised system that supports productivity, sustainability, and long-term industry harmonisation.

The National Rail Knowledge Exchange Standard establishes a non-mandatory, nationally consistent digital data framework, enabling rail operators, maintainers, asset owners and infrastructure managers as well as manufacturers and suppliers to communicate and share information using a common asset identification and digital data structure.

The NRKE builds on Project i-Trace, initiated by the rail industry and the Australian Rail Association (ARA) and developed using ISO certified GS1 global data standards, to deliver a standardised digital environment that:

- Provides globally aligned asset identification (GS1 standards)

- Enables structured, non-commercial-in-confidence data exchange across the supply chain.

This forms the digital backbone for interoperability, improving efficiency, sustainability, and consistency, without introducing additional regulatory burden.

The diagram below illustrates how the GS1 standard and the NRKE will operate together to enable the secure and standardised sharing of digital asset information between railway network operators, maintainers, asset owners and infrastructure managers.

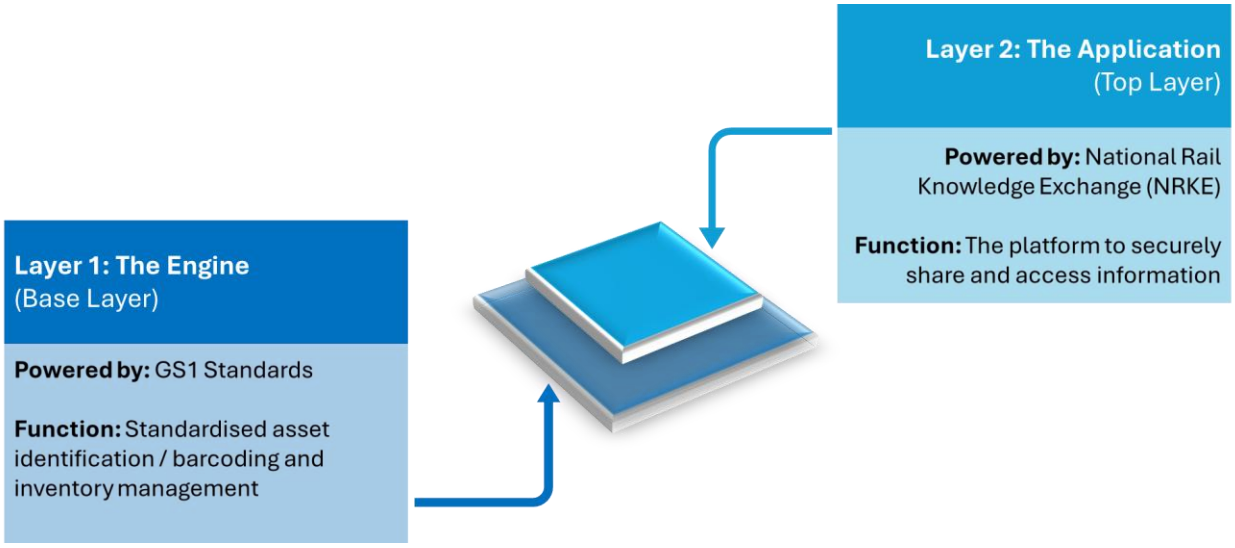


Figure 3 – the layered relationship between the NRKE and the existing GS1 standards

In order to implement the NRKE, the process will involve:

1. Collating the asset information and populating the existing NPC Bulk Data Upload Form. (GS1 NPC Xpress Rail Data Template *version 2.5.0*)
2. Uploading the data to a data validation layer which will check and confirm that the data is in the correct format.
3. Uploading of the template to the NRKE Platform
4. Accessing the data via the NRKE Platform by registering for an account.

This process is illustrated in the figure below:

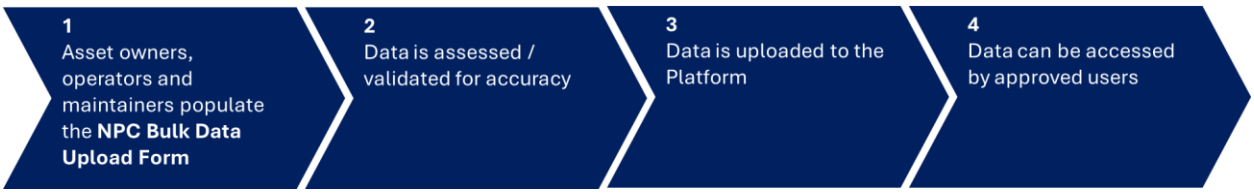


Figure 4 – the implementation process of NRKE

6.2 Project i-TRACE

Project i-TRACE was established in 2016 through collaboration between the Australian railway industry, the Australasian Railway Association (ARA), and GS1 Australia to address inefficiencies and fragmentation across rail supply chains.[14]

The initiative provides a nationally consistent approach to identifying, tracking, and managing rolling stock components throughout their lifecycle by adopting internationally recognised GS1 digital data standards. This creates a common digital framework that improves traceability, procurement efficiency, interoperability, and information sharing between rail operators, maintainers, manufacturers, and suppliers.

Project i-TRACE comprises two key components, the asset identification and traceability framework and the National Product Catalogue (NPC) detailed in the sections below.

6.2.1 GS1 Asset Identification and Traceability Framework

This component enables the unique identification and traceability of products across the entire supply chain lifecycle.

The framework utilises internationally recognised GS1 standards including:

- Global Location Number (GLN)
- Global Trade Item Number (GTIN)
- Serialised Global Trade Item Number (SGTIN)
- Serial Shipping Container Code (SSCC)

These identifiers provide a standardised digital language for components improving consistency, traceability, inventory management, and interoperability between organisations.

6.2.2 National Product Catalogue (NPC)

The National Product Catalogue (NPC) is a central repository of standardised rolling stock components and component information maintained by suppliers. Suppliers can upload and publish their data to the NPC and share the master data with customers.

It supports consistent master data, improved procurement and inventory management, reduced duplication of component records, enhanced lifecycle management, and greater interoperability across rail networks.

[14] Australasian Railway Association. (n.d.). *Project i-TRACE*. Retrieved June 2026, <https://ara.net.au/priorities/technology/project-i-trace/>

Figure 5 – current framework and information flow between publishers and recipients

While the NPC allows for consistent communication of product information from suppliers to purchasers, a significant opportunity still exists for harmonisation between the 29 Australian railway network operators, maintainers, assets owners and infrastructure managers who can leverage the same digital data standard to share information.

7 Benefits of National Adoption

7.1 Industry Benefits

Project i-TRACE has demonstrated significant potential benefits for the Australian rail industry, including:

- Up to 50% reduction in data collection costs
- Significant improvements in asset traceability
- Faster identification and registration of parts and serial numbers
- Reduced inventory duplication and stock holdings
- Improved supply chain efficiency and resilience
- Enhanced opportunities for harmonisation and collaborative procurement.

Other potential benefits of using GS1 Standards are illustrated in the figure below:

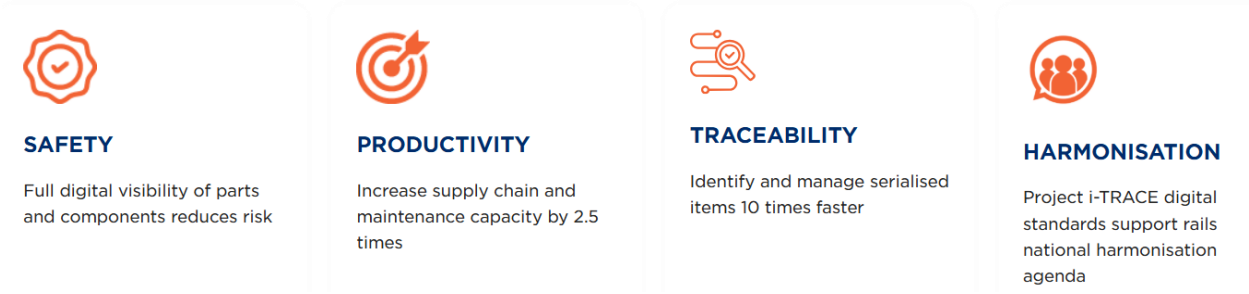


Figure 6 – potential benefits from adoption of GS1 standards

7.2 Organisational Benefit

The Australian rail industry is constrained by fragmented asset data, limited visibility, and inconsistent practices, which reduce interoperability, drive duplication, and increase cost.

The NRKE standard, enabled by Project i-Trace and GS1, addresses these challenges through a nationally consistent digital data framework.

7.2.1 Fragmented Asset Identification

Establish a common, GS1-based asset identification framework to enable a single, standardised digital language across the industry supporting Interoperability of tracking and asset management systems across organisational boundaries.

7.2.2 Siloed asset and component data

Enable lifecycle-based traceability to provide end-to-end visibility of assets, improving safety, efficiency, and decision-making allowing Rail operators and Rail Infrastructure Managers to effectively track and trace all their parts, components and assets, reducing costs and improving safety.

7.2.3 Inconsistent engineering and approval practices

Implement a standardised data model and National Product Catalogue to support consistent specifications, data modelling whilst enabling engineering type approval harmonisation.

7.2.4 Disconnected, fragmented network systems

Introduce a unified digital data framework to enable seamless communication across jurisdictions and organisations.

7.2.5 Duplication and inefficiency

Leverage standardised, reusable asset data and component libraries to reduce rework, lower costs, and improve productivity

The NRKE Standard provides the foundational digital layer required to enable true national interoperability, transforming fragmented asset data into a connected, traceable, and standardised system that supports productivity, safety, and long-term industry harmonisation.

Interdependency with other areas of Rail include:


Improved Safety


Efficient and more accurate stock takes


Predictive Maintenance & Condition Monitoring


Life Cycle management


Warranty management


Inwards good receipts


Advanced warehousing processes


Transport management processes

7.3 Economic Benefit

7.3.1 Economic Benefit – National

The Centre for International Economics (CIE) has conducted an economic analysis (June 2025) on the value of supply chain standards on the Australian economy on behalf of GS1.The key 4 areas where benefits will mostly be achieved are:

In 2025 the ARA estimated the contribution of Manufacturing and Supply within the rail sector to be 3.0 billion dollars which is equivalent to a 7.7% of the value of the rail industry OR 0.2% of Australia's overall GDP.

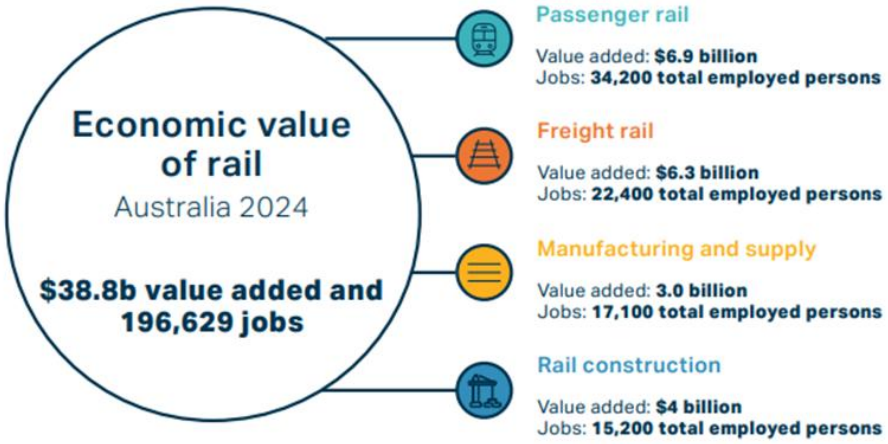


Figure 7 – the economic scale of the rail industry in Australia

Whilst it is difficult to ascertain the value potential of Rail's manufacturing and supply-chain, estimates of the intended benefits include:

- 50% Cost savings in data collection
- 10x Time savings in identification & Registration of parts, materials and serial numbers.
- 20% Reduction in stock levels.

As a contribution to Australia's economy, it is estimated that a national uplift of between $19B to $27B can be achieved per year in GDP. Competition benefits for industry and consumer price index are permanently lower by 0.4% to 0.6%.

7.3.2 Economic Benefit – Organisational

Historic business cases by state rail organisations estimate that a Benefit-Cost-Ratio of 4.4 for Fleet & a BCR of 2.2 for infrastructure is achievable. A summary of estimated costs and benefits at an organisational level is provided in Table 1 & Table 2 below.

	Fleet		Infrastructure	
Item	Year 0-2	Year 3 – 10 p.a	Year 0 - 2	Year 3 – 10 p.a
PDE Equipment	$106,000	$17,025	$54,000	$8,475
Labels	$528,317	$355	$483,634	$402
Middleware	$226,000	$40,000	$226,000	$40,000
Labour	$421,197	$32,906	$292,067	$18,254
Project Management	$187,500	$0	$187,500	$0
IT (Estimate)	~$2,000,000	~$100,000	~$2,000,000	~$100,000
TOTAL (Inc. IT Estimate)	**$3,469,013**	**$190,286**	**$3,243,201**	**$167,132**
Contingency (10%)	$346,901	-	$324,320	-
GRAND TOTAL	**$3,815,914**	**$190,286**	**$3,567,521**	**$167,132**

Table 1: Annual Costs

			Fleet			Infrastructure		
Area	**Benefit Category**	**Indexed**	**Opportunity**	**Deliverability**	**Annual Expected Value**	**Opportunity**	**Deliverability**	**Annual Expected Value**
Supply Chain	Warehouse Productivity	Yes	$168,000	100%	$168,000	$425,000	100%	$425,000
	Inventory Accuracy	No	$268,000	50%	$130,000	$1,300,000	50%	$650,000
	Scanning Serialised Materials	Yes	$6,000	50%	$3,000	$114,000	50%	$57,000
Asset Management	Repairable Batch & Shelf Life	No	$210,000	50%	$105,000	-	-	-
	Maintenance Productivity	Yes	$5,000,000	10%	$500,000	$5,000,000	10%	$500,000
	Returns	No	$2,000,000	10%	$200,000	$2,000,000	10%	$200,000
	Warranty Management	No	$36,000	50%	$18,000	$481,000	50%	$241,000
					$1,124,000			**$2,073,000**

Table 2: Annual Benefits

8 Analysis and Prioritisation

8.1 Analysis

- **Options Analysis**: Interlink Aus undertook an options analysis against the ARISO and NTC National Rail Standards Framework, identifying clear trade-offs across Strategic Value, Implementation Feasibility, and Stakeholder Commitment and Adoption Readiness.
- **Multi-Criteria Analysis**: A structured Multi-Criteria Analysis (MCA) framework was developed to assess options using aligned qualitative and quantitative criteria consistent with the National Rail Standards Framework.
- **Strategic Fit**: A nationally consistent digital data framework ranked highest across the MCA and framework testing, demonstrating strong strategic alignment, high feasibility, and integration with existing initiatives (NRAP, NNI, and ARISO programs).
- **Cost Benefit**: The proposed standard delivers a high-return, low-risk, and scalable implementation pathway when assessed against cost, capability, and broader industry and economic benefits.
- **Industry Feedback**: Interlink Aus undertook further industry engagement by developing a survey completed by industry partners and key Subject Matter Experts.

The results of our analysis indicated:

- Industry Collaboration Needs – Survey shows strong desire for collaboration despite fragmented and informal current practices.
- Operational Challenges Identified – Minimum Order Quantities and reduced OEM support cause inefficiencies and duplicated efforts across the networks.
- Support for Improvement Mechanisms – Respondents support shared databases, workshops, and communities to improve knowledge sharing and coordination
- Opportunity for Neutral Framework – A neutral ARISO led framework could enhance trusted information sharing and deliver sector-wide benefits.

8.2 Prioritisation

The National Rail Knowledge Exchange (NRKE) Standard is proposed to be a non-mandatory, Tier 2 Harmonised Standard in accordance with the National rail Standards Framework.

The standard forms the digital backbone for interoperability, improving efficiency, safety, and consistency, without introducing additional regulatory burden. The NRKE allows voluntary industry adoption whilst clearly defining core principles, standard structure and Governance & Ownership models.

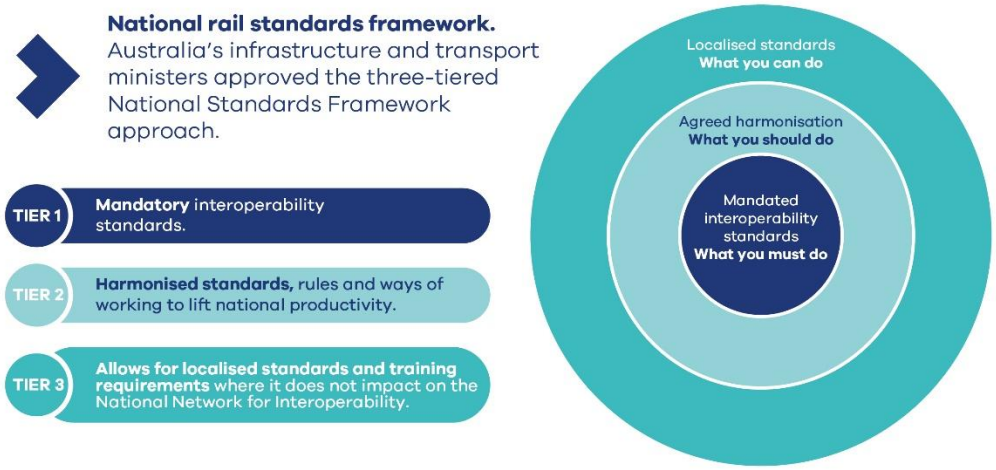


Figure 8 – the National 'three-tiered' rail standards framework

8.3 Case Studies

8.3.1 Sydney Trains

Sydney Trains has initiated a business case for a barcoding project that aligns with the standards set by the ARA through project iTrace. The project is to cover inventory management for both fleet and infrastructure aspects with optioneering for implementation currently under review. The benefit costs ratio (BCR) is in close alignment with the values summarised in subsection 7.3.2.

8.3.2 Queensland Rail

In September 2023, Queensland Rail deployed mInventory, a mobile-enabled inventory management solution across its primary Network and Operating Assets warehouses, as a part of the industry-led Project i-Trace supported by the Australian Rail Association (ARA) and GS1 Australia. The initiative improved efficiency, accuracy and workforce mobility by reducing manual data entry and enabling real-time inventory visibility. More

broadly, mInventory demonstrates how targeted digital enablement, underpnned by gloabl data standards, can deliver immediate operational benefits while establishing a scalable foundation for a nationally interoperable rail data ecosystem aligned with i-trace and emerging NRKE objectives.

8.4 Risks & Constraints

Interlink Aus conducted a Survey to gain industry insights on the current risks and barriers for sharing the information and knowledge specifically in rolling stock operation and maintenance space.

The key risks and constraints include:

- **Commercial Sensitivity and Competition**
  This was listed as one of the key barriers for harmonisation, as often the Operators, Suppliers and Maintainers are direct competitors. Resulting in reluctance to share information, promoting the industry fragmentation limiting collaboration, even when mutual benefits exist.
- **Lack of Standardisation**
  Inconsistent standards, requirements and approvals across the states leads to inconsistent approach for structuring and managing asset information. Reduces interoperability and complicates sharing of solutions.
- **Lack of Platforms, Tools, and Systems**
  No structured and centralised system available for industry partners to share information publicly. Knowledge exists but is not accessible or structured.
- **Time Constraints**
  Knowledge sharing is not embedded into requirements and contracts. Knowledge sharing seen as additional effort beyond daily responsibilities. Hence, no incentive leads to no initiative.
- **Missed collaboration**
  Missed collaboration opportunities, duplication of effort, and inefficient procurement decisions due to limited visibility of fleet and equipment supplied and/or operated across the country. Often, collaborations are limited and mostly driven through the personal connections that industry personnel build up overtime.
- **MOQ**
  Inefficient capital utilisation and wasted inventory due to Minimum Order Quantity (MOQ) exceeds actual needs of the Organisations. Organisations to maintain relatively smaller fleet are forced to purchase excess inventory.

- **Bespoke Solutions**
  Reinventing solutions as the needs arise due to operation or maintenance needs. Organisations tend to develop bespoke solutions to resolve the issues for managing the fleet performance. These non- standard solutions are often approached due to lack of awareness of existing solutions fragment the rail industry further.

8.5 Regulatory & Compliance

The NRKE standard will comply with Australian legislation and regulatory requirements as well as existing Australian standards. The following legislation and standards have been considered.

- **Security of Critical Infrastructure Act (2018)** – rail is one of the 11 critical infrastructure sectors covered under the SOCI Act. Cybersecurity and risk management requirements are a key area where the NRKE will be designed to comply. A reform in 2024-2025 has also expanded the SOCI to cover data storage and processing including ransomware payment reporting and smart device security standards.
- **Privacy Act (1988) and Australian Privacy Principles (APP)** – The NRKE will handle asset data however, if there is any link to individuals than the Privacy Act and APP will apply. Key obligations for compliance have been considered including transparent management, collection of solicited information and reporting of notifiable data breaches.
- **Archive Act (1983) and State Records Act** – The NRKE will generate and store records in compliance with national and state level legislation.
- **Copyright Act (1968) and Patents Act (1990)** – Intellectual property has been considered and thus the platform is proposed to only contain non-commercial-in-confidence asset data.
- **Competition and Consumer Act (2010)** – Anti-competition behaviour has been considered and thus the platform is proposed to only contain non-commercial-in-confidence asset data.
- **Disability Discrimination Act (1992)** – the standard considers that the NRKE platform should be accessible and comply with the Web Content Accessibility Guidelines.
- **AS/NSZ ISO 27001 Information Security Management** – the NRKE platform will comply with the ISO 27001 standard for information security management given that it will handle rail asset data.
- **AS/NZS ISO 55000 Series Asset Management** – these standards provide the overarching framework for asset management that the NRKE supports.

- **GS1 Standards** – the NRKE is built upon GS1 standards which are compliant with international standards including ISO/IEC 15145 and ISO/IEC 15146 Barcode and QR Code Quality Standard, ISO/IEC 15418 and ISO/IEC 15459 Unique Item Identification Standard.
- **National Transport Commission – National Rail Standards Framework** – an assessment has been conducted to determine where the NRKE would sit under the NTC's National Rail Standards Framework to ensure compliance with the national agenda.

9 Implementation

9.1 Structure of Standard

The recommended structure for the standard is as follows:

Part A - Context and intent

- Relationship to NRAP and National Rail Standards Framework
- Relationship to ISO 55000 and ARISO standards
- Non-mandatory status and intended audiences

Part B - Asset identification model

- Recommended use of GS1 identifiers (e.g. GIAI for individual assets) by reference, not redefinition
- Principles for labelling, marking, and digital association
- Handling of legacy assets

Part C - Minimum asset data sets

- Core attributes (identifier, asset class, owner, location, lifecycle status)
- Maintenance and configuration history principles
- Alignment with Project i-TRACE outcomes

Part D - Information governance

- Data ownership and stewardship
- Handover between entities
- Evidence and traceability expectations consistent with ISO certification assurance requirements

Part E - Adoption guidance

- Example use cases
- Maturity progression models
- Mapping to common Enterprise Asset Management Systems (EAMS) / CMMS systems

Part F - Adaptation (Optional)

- Integration into national digital data platform
- Adaptation into other systems or processes using industry benchmark.

9.2 Core Principles

The standard would be principles-based, consistent with ISO certified GS1 Standards.

- **Single source of asset identity** - Each physical asset should have one persistent, unique identifier across its life.
- **Lifecycle continuity** - Asset data must persist from manufacture → commissioning → operation → maintenance → disposal.
- **Interoperability by default** - Asset data should be exchangeable across operators, maintainers, and supply chain participants.
- **Fit-for-purpose data** - Data requirements scale with asset criticality and risk.
- **No forced technology choice** - Organisations may choose systems, provided outputs align with the framework.

9.3 Governance & Ownership Model

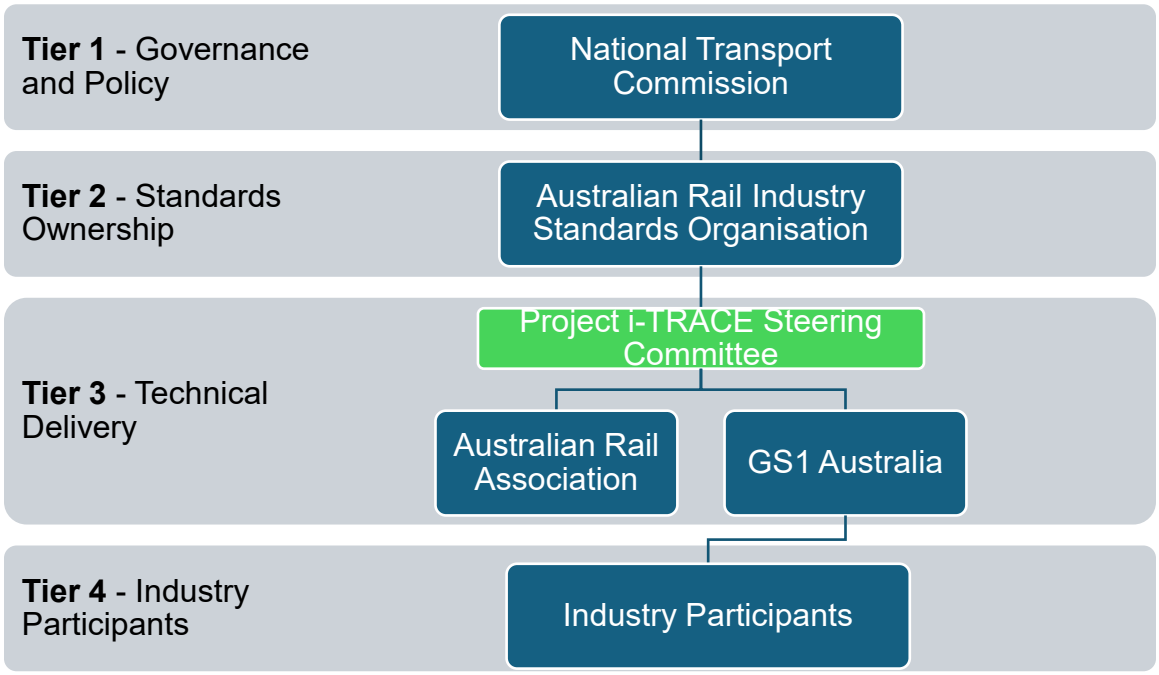


Figure 10 – the proposed governance & ownership model in alignment with

In interviewing with key members of project iTrace, a significant barrier to widespread adoption was identified, the delay between significant upfront user input and realised benefits. To address this barrier, the NRKE brings forward the unrealised benefit of iTrace – standardised component information that can be shared with other rail entities.

Utilising iTrace to track all components on a vehicle can take significant time to implement and train users in, however constructing the digital library of the components

requires marginally less time and effort. Having multiple rail entities performing the first step of creating a digital library and sharing this through the NRKE unlocks the benefits of collaboration identified earlier in this report while also starting the process of implementing iTrace, making the continuing the implementation a much less daunting task.

GHD identified three possible pathways for harmonisation in their report:

- **Voluntary pathway**
  - Described as an “enhanced status quo”. An incentive lead adoption of standards supported by governance. Increased knowledge and promotion of standards – but relies on industrial appetite for change.
  - Time scale for implementation is estimated at under 10 years.
- **Gradualist pathway**
  - Establishment of focused mandatory standards which are of high benefit to industry. Existing equipment and infrastructure would be grandfathered in under their own applicable standards.
  - Time scale for implementation is estimated between 5 to 10 years.
- **Interventionalist pathway**
  - A rapid mandatory uptake of harmonising standards with minimal grandfathering of existing equipment/infrastructure standards. This approach requires high level of oversight and government funding.
  - Time scale for implementation is estimated at approximately 5 years.

A gradualist approach to implementation is proposed for our selected standard. It is anticipated that with a mandatory establishment of a shared digital library of vehicle components, which could be realised within 1-2 years nationally, the uptake of i-Trace as a total system will be self-driving and could be established within 5 to 7 years.

The implementation and governance of this process is to be overseen by ARISO to ensure that the digital library is contributed to by all participants in the correct format.

9.4 Future Expansion Works

- The NRKE maturity progresses from fragmented, siloed systems to a fully integrated, intelligent national rail network enabled by standardised asset identification and interoperable digital data. **Level 1 – Fragmented (Current State)**Disconnected asset systems across operators and jurisdictions
- Inconsistent asset naming, classification, and identification
- Limited data sharing; siloed supplier and operator information
- Repeated assurance, design, and procurement activities

Level 2 – Standardised Foundation

- Adoption of GS1-based asset identifiers (i-Trace aligned)
- Establishment of a common data structure and taxonomy
- Basic capability for non-commercial data exchange
- Early adoption by key operators and suppliers

Level 3 – Connected Digital Ecosystem

- Integration of NRKE with:
  - Asset management systems
  - Supplier and OEM data environments
- Expansion across multiple asset classes (track, civil, signalling, rollingstock)
- Defined data governance and ownership frameworks

Level 4 – Integrated Lifecycle

- End-to-end asset lifecycle data integration:
  - Design → Construction → Operations → Maintenance → Disposal
- Alignment with NRAP and National Network for Interoperability (NNI)
- Standardised data flows embedded in procurement and delivery models
- Broad national adoption across operators and supply chain

Level 5 – Optimised & Intelligent

- Fully interoperable, nationally connected digital ecosystem
- Real-time data exchange across all stakeholders
- Advanced analytics, predictive maintenance, and optimisation
- Integration with:
  - Digital train control (e.g. ETCS environments)
  - Digital twins and network simulation

10 Conclusion

The National Rail Knowledge Exchange (NRKE) provides a practical and scalable solution to one of the rail industry's most persistent challenges—fragmented information and limited cross-network collaboration. By establishing a secure, standardised digital framework underpinned by GS1 standards, the NRKE enables consistent asset data sharing across operators, maintainers and asset owners.

This standard directly supports national harmonisation efforts and aligns with key industry programs, providing a clear pathway to improved interoperability, productivity and long-term network efficiency. The NRKE positions the Australian rail sector to move beyond isolated systems toward a unified, data-driven future.

11 Definitions & Terms

ARA	Australian Rail Association
ARISO	Australian Rail Industry Standards Organisation (formerly known as RISSB)
BCR	Benefit-Cost-Ratio
CMMS	Computerised Maintenance Management System
EAMS	Enterprise Asset Management Systems
GHD	A multinational technical professional services firm providing advisory, architecture and design, buildings, digital, energy and resources, environmental, geosciences, project management, transportation and water services.
GIAI	Global Individual Asset Identifier
GLN	Global Location Number
GS1	GS1 is a global, neutral, non-profit standards organisation that introduced the barcode in 1974, providing a common language to the industry.
GTIN	Global Trade Item Number
Interlink Aus	Project team as described in Section 2
MCA	Multi-Criteria Analysis
MOQ	Minimum Order Quantity
NAPs	National Access Points
NLCSC	National Level Crossing Safety Committee
NLXP	National Level Crossing Portal
NNI	National Network for Interoperability
NPC	National Product Catalogue
NRAP	National Rail Action Plan

NRKE	National Rail Knowledge Exchange
NTC	National Transport Commission (NTC) is an Australian government agency that leads land transport reform
ONRSR	Office of the National Rail Safety Regulator
Project i-Trace (Or i-Trace)	Project i-Trace is an industry-wide initiative using a standardised barcoding system to collate data on assets and materials used across the rail industry. Initiated by the rail industry and the ARA to digitise inventory management, automate all steps in the supply chain and provide critical information throughout the life cycle of a product, part or component using ISO certified GS1 global data standards.
RISSB	Rail Industry Safety Standards Board
SGTIN	Serialised Global Trade Item Number
SSCC	Serial Shipping Container Code
TSI	Technical Specifications for Interoperability

12 Further Information and References

Ref No.	Title	Author	Date / Revision
[1]	GS1 Standard enabling the EU digital product passport	GS1	January 2025
[2] [4] [6] [7]	National Rail Action Plan	NTC	November 2025
[3] [8]	RISSB's Work Plan 2025 – 2026	ARISO (RISSB)	December 2025
[5]	Historic step towards a unified national rail system	NTC	August 2025
[9]	Harmonisation of Rail Standards (Research Report)	GHD	October 2024
[10]	Digital Twin White Paper	Standards Australia	March 2023
[11]	National Level Crossing Portal (https://nlxp.com.au/)	NLXP	
[12]	Common European Data Spaces	European Commission	February 2026
[13]	National Access Points	European Commission	October 2025
[14]	Project i-Trace	ARA	June 2026
	Other References		
	GS1 Standards in the Rail Industry - Global identification, labelling and data exchange for parts, components and assets	GS1	November 2021
	AutoID in Rail – Identification of Rolling Stock, Components and Spare Parts in the Rail Sector	GS1	December 2012
	GS1 Standards enabling the EU digital product passport	GS1	January 2025
	National Rail Action Plan Program Overview	NTC	November 2025

13 Appendices

13.1 Survey Results

Survey responses have been collated from personnel representing various aspects of the rail industry. Below is the summary of the response and insights collated.

- **Respondent Profile**

  Respondents represented diverse industry roles across the rail sector, including maintainers, operators, suppliers, consultants, designers, contractors and support staff.

  Input from both front-line operators and strategic planners provided a balanced view of practical challenges and system-level standards.

- **Awareness of Fleets and Networks**

  Many fleet operators have only partial awareness of shared equipment across networks, with knowledge typically fragmented and reliant on informal experience rather than centralised or structured systems. This lack of comprehensive visibility limits opportunities for effective collaboration and contributes to inefficiencies, particularly in managing ageing assets and complex supply chains.

- **Bespoke Solutions and MOQ Challenges**

  Organisations often develop bespoke solutions due to unique needs and limited OEM support, while high minimum order quantities drive excess purchasing, tying up capital and increasing storage and lifecycle costs—highlighting the need for greater cross-industry sharing of parts, inventory, and knowledge to improve efficiency.

- **Collaboration Opportunities**

  Survey respondents show a strong willingness to collaborate through joint purchasing, shared inventories, and open knowledge exchange via workshops and databases. Existing user groups and informal networks already demonstrate the value of such collaboration in enabling mutual support and joint problem-solving. Overall, collective action is seen to enhance resilience, reduce costs, and improve asset support, particularly in the context of ageing fleets and declining OEM support.

- **Barriers to Knowledge Sharing**

Commercial sensitivity, organisational silos, and unclear points of contact significantly limit knowledge sharing across operators, while time pressures and a focus on operational priorities further reduce engagement. The absence of a trusted, centralised platform for sharing equipment information and lessons learned exacerbates these challenges, hindering effective collaboration.

- **Key Takeaways**

  The survey highlights a strong recognition of shared challenges and a clear willingness to collaborate across Australian rail networks, with practical solutions such as shared databases, technical forums, and joint purchasing identified to improve efficiency and knowledge exchange. However, realising these benefits requires overcoming key barriers including commercial sensitivities, organisational silos, time constraints, and the absence of enabling platforms. In this context, Interlink Aus is well positioned to act as a neutral facilitator, providing trusted mechanisms for collaboration while respecting commercial boundaries.