



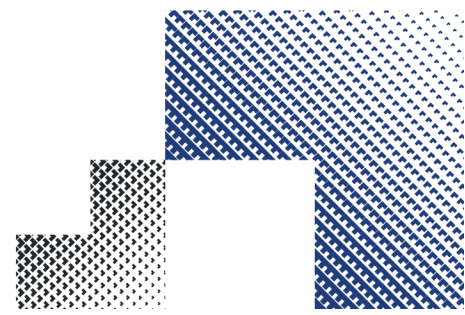
National
Transport
Commission



Digital Train Control Technology Interoperability Requirements Assessment

Discussion paper

National Transport Commission | June 2025



Report outline

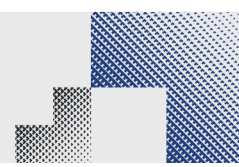
Title	Digital Train Control Technology Interoperability Requirements Assessment
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Executive Summary

Infrastructure and Transport Ministers have tasked the National Transport Commission to work with all governments and industry to tackle long-standing challenges in Australia's fragmented rail sector so rail can play a bigger role in the economy and drive better outcomes for passengers, freight and the rail workforce.

As Australian rail networks move from manual signalling to digital train control technology (DTCT), there is the opportunity for a step-change in safety, productivity and environmental outcomes. The benefits from the current \$155B pipeline of rail modernisation projects will only be fully realised if digital systems are interoperable.

Eastern seaboard states have aligned on European Train Control System (ETCS) Level 2 (L2) as the DTCT of choice for their respective networks, and a strategic business case is being developed on a train control and signalling interoperability pathway for Australia. If states customise and bespoke their ETCS version to fit with legacy ways of working, there is a risk that different systems won't connect and new, long-lasting interoperability challenges may be introduced.

Rail interoperability is a priority of National Cabinet and ministers have endorsed the need for the first mandatory interoperability standards to avoid a 'digital break of rail gauge', and to the development of a national standards framework to advance 'must have' interoperability standards, and 'model' standards to drive harmonisation.

The purpose of this paper is to explore the scope for the first mandatory ETCS standards. It draws on the structures and lessons learnt from ETCS deployment over the last 20 years, taking a whole-system perspective, encompassing trackside and onboard components. It looks at ways the European Technical Specifications for Interoperability (TSIs) could be leveraged in Australia, while assessing the critical factors that must be specified or aligned to achieve interoperability in a co-regulatory environment.

There are four key topic areas where feedback is sought:

1. **Alignment with EU TSIs** to ensure that all ETCS implementations in Australia align with an agreed application of the European Union Agency for Railways' (ERA) European Technical Specifications for Interoperability (TSI). It should be noted that not all elements of the TSIs will be relevant in Australia.
2. **Common certification of onboard installations for compliance to ETCS specifications** to ensure that a vehicle fitted with compliant ETCS and radio equipment can travel unhindered and efficiently across the NNI.
3. **Flexibility in trackside implementations** to give Rail Infrastructure Managers (RIMs) some flexibility in how ETCS is deployed trackside—within defined boundaries—to address specific network needs. Certified vehicles must remain compatible with all trackside configurations. Wherever feasible, deployments will be based on a limited number of generic configurations to permit close alignment of operating arrangements and rules.

4. **National coordination** to manage updates to the TSIs and provide clarity for application in Australia, as well as managing standards and non-compliances, overseeing certifications, and coordinating national planning.

Interoperability Requirements Assessment Report overview

Sections 1, 2, 3, and 4 set out the interoperability imperative for Australia and the context for national standards development. They provide a comparison with railways overseas and show how arrangements in Europe and the United Kingdom could be leveraged to achieve and maintain interoperability of ETCS implementations across the Australian rail network.

Having set out this context, the following sections of the document analyse the requirements for achieving and maintaining interoperability of ETCS implementations across the Australian rail network.

Section 5 Technical Requirements for Interoperability provides an overview of the detailed technical requirements that relate to ETCS interoperability. It looks at the extent and manner by which these might need to be applied on a mandatory basis to achieve ETCS interoperability in Australia. Feedback is sought on these requirements to ensure the proposed mandatory standards for Australia are appropriate and proportionate to our interoperability objectives.

Section 6 Managing Interoperability during Delivery looks at how Australia could leverage the European certification process within the TSI, the Interoperability Directive and other legislative elements. This adaptation should ensure that the adapted standards embed the lessons learnt overseas and maximise the opportunity for cross acceptance with what is already certified. Feedback is sought on the extent to which equivalent arrangements might be needed in Australia to support our interoperability objectives within the specific regulatory environment of the Australian railway sector.

Section 7 Ongoing Interoperability Management considers how alignment across networks can be managed over time to accommodate changes in technologies and deployment plans; manage points of disagreement; and maintain the standards and requirements expected of individual rail entities. In Europe many of these tasks are undertaken by the European Union Agency for Railways (ERA). Feedback is sought on the appropriate balance between the need for national coordination and the need for RIMs and RSOs to maintain appropriate authority and flexibility in managing their own operational outcomes.

Section 8 Allocation of interoperability requirements summarises how the various requirements for interoperability could be addressed – through mandatory standards, by national coordination or through alternative mechanisms.

Emerging view of standards and structure

Based on the analysis of this report, Table 1 summarises how the key elements to be codified into standards to manage interoperable DTCT may fit within the proposed three-tier national rail standards framework. The proposed standards will help RIMs/network authorities and RSOs apply ETCS to their vehicles and networks.

	DTCT Trackside and Onboard elements to be codified to guide the application of ETCS to networks and vehicles
Tier 1 Mandatory standards	• Australia's response to the TSIs ➤ ETCS baselines and system versions to be installed and allowed for ➤ Defining applicable and not applicable parts of the TSI for Australia ➤ Identifying functions in the TSI not to be used in Australia ➤ Permissible deviations to the TSIs ➤ Requirements for managing non-compliances • Radio requirements for interoperability • Assurance requirements for compliance and certification
Tier 2 Harmonised standards	Yet to be determined, but may include: • Preferred configurations for different circumstances, e.g. urban, regional, rural and remote • Recommended variables, e.g. national values, or degrees of freedom in variables • Example design concepts, solutions, layouts and reference designs for trackside and/or onboard cabs • Interfaces and integration with other systems (e.g. EULYNX)
Tier 3 Local standards (Optional)	Yet to be determined, but may include: • Specific local variables and configurations to be applied, e.g. to address interfaces with legacy arrangements • Local requirements, e.g. for contained fleet (such as Sydney electric fleet, specific system interfaces) • Responses to local workforce requirements

Table 1. An indication of how the DTCT trackside and onboard elements that need to be codified to guide the application of ETCS may fit into the proposed three-tier national rail standards framework.

Next steps

Feedback is invited from relevant parties on the content of this Interoperability Requirements Assessment and the proposed scoping for the two mandatory standards.

Throughout this document, we have presented questions that align with the narrative and analysis of each section. Respondents are encouraged to consider the supporting arguments and analysis before providing their input using the supplied pro-forma.

Responses are particularly encouraged from:

- Rail Infrastructure Managers, especially those that manage part of the NNI.
- Rolling Stock Operators, especially those that operate on the NNI.
- DTCT equipment suppliers.
- Delivery organisations involved in past and current DTCT initiatives.
- Governments / Infrastructure Authorities, especially those that set strategies for investment on networks forming part of the NNI.
- Unions.

Your written input is sought and focused workshops will also be conducted. Feedback will be analysed and consolidated to enable the NTC to provide advice to Infrastructure and Transport Ministers in late 2025 on the proposed scope for two national mandatory standards.

1 About this project

1.1 Rail interoperability is a priority of National Cabinet

Through the National Rail Action Plan (NRAP), the NTC is working to reduce differences and support a safe and efficient, modern rail network. The current four-year NRAP Interoperability Program, endorsed by National Cabinet, is focusing on harmonising the most critical rail standards and processes, ensuring train control systems are interoperable, streamlining rolling stock approvals and addressing key rail skill shortages. Underpinning the program's delivery is developing a national approach to rail standards.

The current opt-in nature of standards means there are many differences in rail operations, rolling stock and network investments. The National Rail Standards Framework will create greater consistency and drive interoperability, safety, innovation and support local supply chains. The framework is articulated around 3 Tiers explained in more detail in section 2.1:

- Tier 1 Mandatory Standards, focusing on achieving Interoperability on the NNI
- Tier 2 Harmonised standards, focusing on lifting productivity
- Tier 3 Localised standards

1.2 This stage of the process

Following on from the initial consultation in 2024, the NTC has been tasked by Ministers to develop the mandatory standards necessary to ensure this interoperability, and this workstream will scope the technical requirements and outline a proposed scope for two of the Tier 1 mandatory standards to support a European Train Control System (ETCS) implementation pathway across the National Network for Interoperability (NNI).

This stage of the project is focused at scoping the content of the following mandatory standards which are not intended to apply to DTCT implementation based on other technologies than ETCS:

- “Digital Train Control Technology” Standard (which is proposed to be renamed as DTCT-Trackside Standard) – a standard for Rail Infrastructure Managers (RIMs) (trackside/infrastructure standard) that outlines what needs to be installed on the network to ensure effective interoperability, including (but not limited to) compliance with the relevant Technical Specifications for Interoperability (TSI).
- “Single On-board Interface for driver and crews”, which is proposed to be renamed as Digital Train Control Technology Onboard standard (DTCT-Onboard Standard) – a standard for rolling stock/locomotives (on-board standard) that details the requirements for on-board train equipment, including the necessary configuration elements for the RIM areas where the train is permitted to operate.

A separate process is underway on the third Tier 1 standard, Streamlining rolling stock approvals.

This process is in an exploratory phase. This stage of work will not develop the standards themselves but aims to conduct a detailed assessment and review of requirements and specifications and to set out, for consultation and engagement with the rail sector, the options and rationale behind the potential content of each standard.

This stage principally focuses on the content of the standard which could impact the definition of the Trackside and Onboard subsystems. It also explores the assurance and governance requirements, where there are aspects necessary during the introduction of new assets or modification of existing ones to achieve outcomes compliant to the standards.

1.3 Approach

Following the decisions on specific Digital Train Control Technologies made by impacted rail networks, and coordination work by NTC through the National Rail Action Plan, the national rail sector is broadly aligned on the use of ETCS as its core DTCT. Accordingly, this analysis focusses on the necessary steps to align deployments of ETCS, and related systems (e.g. radio, etc.), to ensure interoperability.

With the European heritage of ETCS, this work necessarily looks to the structures in place in Europe to manage ETCS, including the TSIs, and the lessons learned from the various developments across Europe and the UK to evaluate how an appropriate framework and set of requirements can be established across the Australian rail networks to ensure interoperability.

Three documents have been prepared to seek industry and stakeholder feedback to inform consideration around options towards mandatory interoperability standards:

- The Interoperability Requirements Assessment
- DTCT Trackside Discussion Paper
- DTCT Onboard Discussion Paper

This initial paper, the Interoperability Requirements Assessment, addresses each of the topics summarised below:

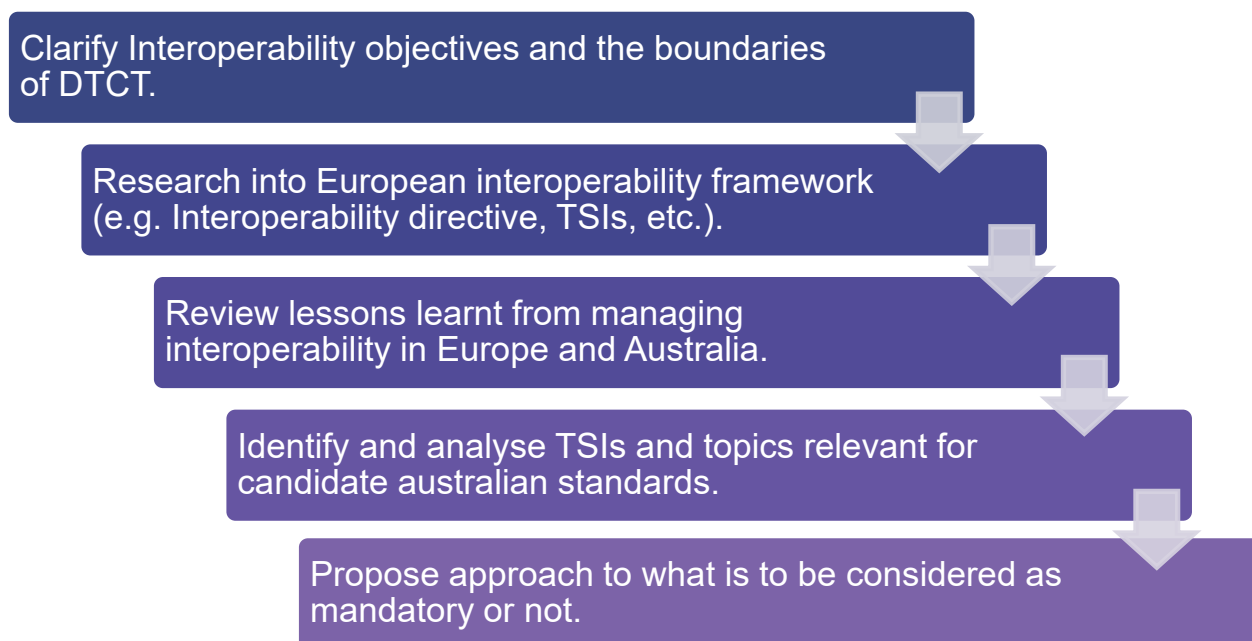
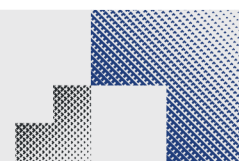


Figure 1. Areas covered by this Interoperability Requirement Analysis



NRAP extends beyond the development of the Tier 1 mandatory standards for interoperability and includes the identification and development of Tier 2 harmonised standards to increase productivity. While this assessment focuses on aspects related to the mandatory standards (i.e. Tier 1), topics related to improving productivity may be identified and submitted to consultation for inclusion or allocation to a Tier 2 standard.



2 Interoperability Framework for the Australian railway network

2.1 National approach to standards

The NTC is developing a National Rail Standards Framework consisting of three Tiers: mandatory, harmonised and local standards.

This report evaluates the following considerations: technical, process/delivery, and ongoing interoperability management and proposes different approaches to achieve interoperability. The report determines if the proposed approaches should be classified as mandatory or not, in accordance with the NTC figure shown below.

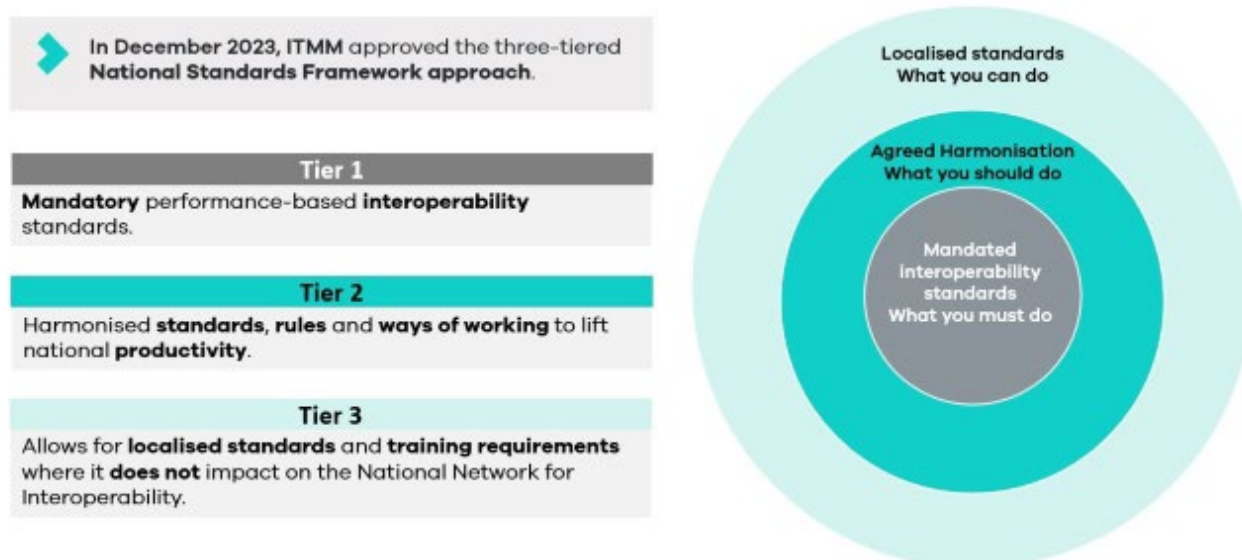


Figure 2. National Rail Standards Framework

2.2 The National Network for Interoperability

Under the National Rail Action Plan, the concept of a National Network for Interoperability (NNI) has been defined as the interstate railway lines that move passengers and freight from terminal to terminal and port to port. The NNI was approved by ITMM in February 2022 and is shown in Figure 3. The definition of the NNI is not static its evolution will be managed separate to the definition of these standards.

The NNI provides a focus for interoperability considerations, and it is proposed that the national standards (as per the above framework) would apply primarily to the NNI and to rail operations on

the NNI – noting that other networks and users may elect to adhere to the requirements of the standards for their own purposes.

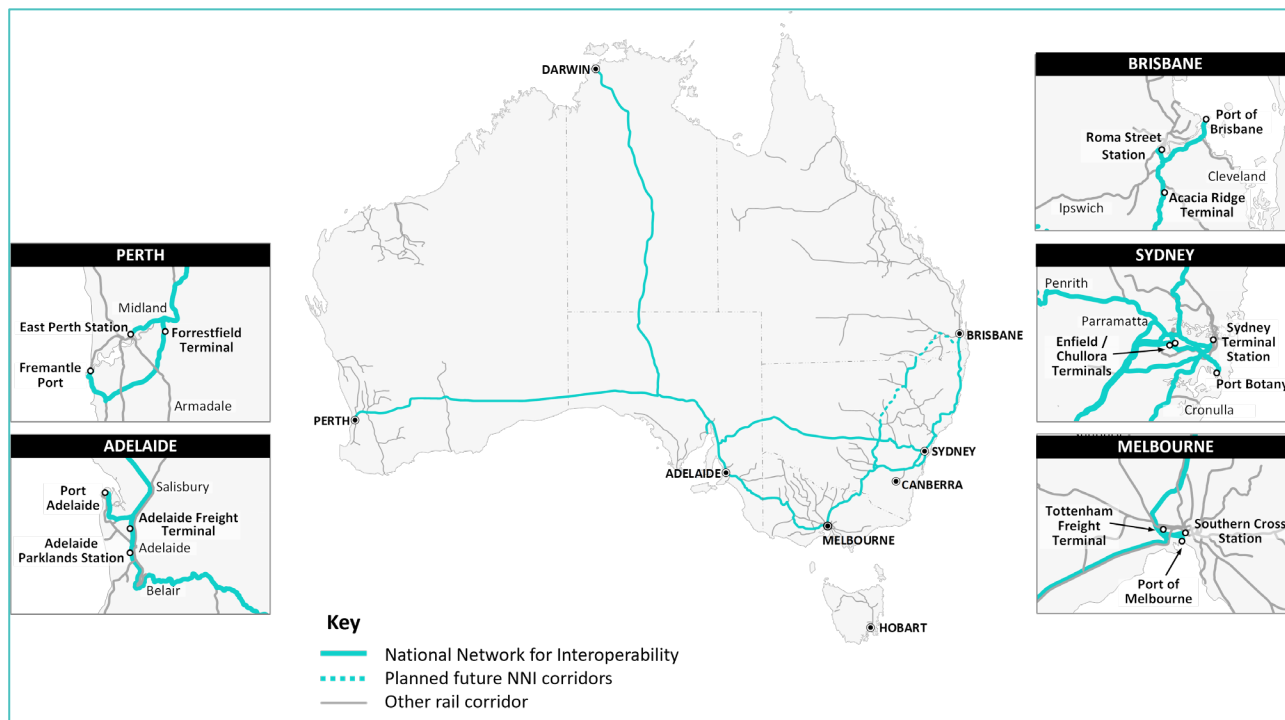


Figure 3. Indicative National Network for Interoperability

It is worth noting and considering for the reading of the next sections, that while the focus of this project is to achieve Interoperability on the NNI, rollingstock operating on it are not always captive to it and may eventually operate on other networks. As such, the mandating of DTCT Onboard standard for trains operating on the NNI can have indirect consequences on networks beyond the NNI.

2.3 Definition of Interoperability

For the purposes of this work, the definition of “interoperability” is as follows:

‘Interoperability’ means:

making sure that any train, no matter what network it is going over, can operate so far as practicable at the highest level of safety and productive performance the network offers.

This definition is emerging from the National Rail Action Plan (NRAP) and the update of the Rail Safety National Law which will eventually provide the legal definition. At this stage the definition is broadly aligned with the definition of interoperability used Europe; the slight differences are not expected to impact and introduce complexities in the application of the proposed technology.

The term “technical interoperability” can be found in this document and other NTC documents. This term rather refers to the technical compatibility required or achieved between 2 (DTCT) subsystems in order to achieve the Interoperability defined above.

2.4 DTCT definition and scope

2.4.1 TSIs context

There is no commonly accepted definition of DTCT in Australia or within international standards. However, given the decision to introduce European Rail Traffic Management System (ERTMS- i.e. ETCS, Radio and other), it is proposed to align the definition of DTCT to the definition of its technical subsystems and their interfaces when these are already defined as part of the Technical Specification for Interoperability (TSI) relating to the Control-Command and Signalling subsystems (CCS-TSI, as defined currently by Regulation (EU) 2023/1695). A simplified representation of ERTMS components is shown in Figure 4.

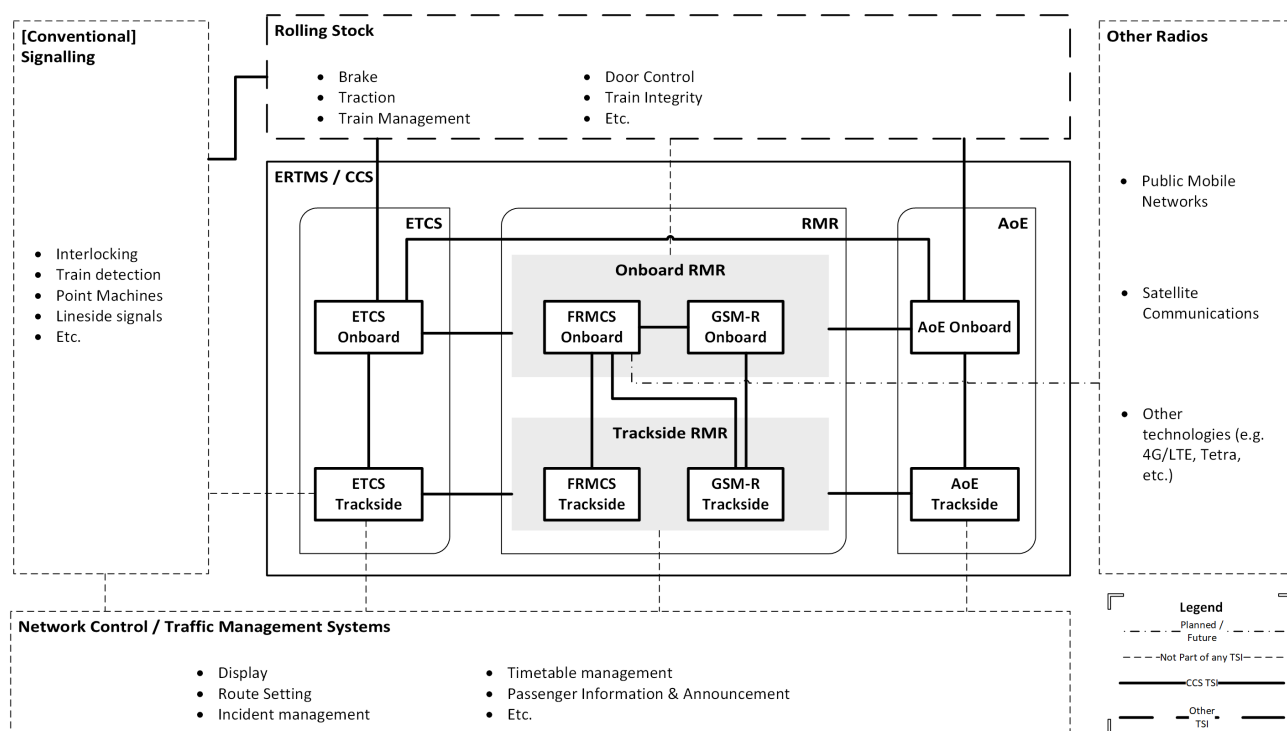


Figure 4. Simplified ERTMS/CCS architecture and context diagram

It is worth highlighting from Figure 4, that ERTMS is only one of the subsystems required to achieve interoperability within the European context. As such some of the functions performed by rolling stock to which ERTMS is to interface to may not be specified by the CCS TSI but rather the equivalent TSI for Rollingstock (Locomotives & Passengers TSI). Similar approach has also been

taken in Europe for operations, where minimum operating rules & procedures (a.k.a. rulebook) are defined in a separate Operation and Traffic Management TSI (TSI OPE) even though the interdependency between both is high.

Note: As explained in more detail in section 3 and 5.3, these standards will not only focus on the CCS TSI, but will also have to include requirements from other TSI if identified as necessary to achieve interoperability.

2.4.2 Proposed definition

The following definition is proposed for DTCT:

‘Digital Train Control Technology’ includes:

- ETCS Onboard train protection/control equipment, and
- Onboard data radio equipment supporting transmission of ETCS data, and
- ETCS Trackside train protection/control equipment, and
- ATO (over ETCS) Onboard, and
- ATO (over ETCS) Trackside, and
- FRMCS Trackside data radio, and
- Conventional signalling elements used in conjunction with the above, and
- Network Control / Traffic Management Systems used in conjunction with the above, and

The proposed definitions of DTCT and Interoperability are to be read in conjunction with, and in light of the development of these Tier 1 standards. Indeed, the items defined as “used in conjunction with the above” are to be understood for the development of the standards as the element relevant from these assets identified as required to achieve the Interoperability objectives.

The definition above identifies the technical areas / subsystems which are proposed to be addressed in the standards but is not to be understood as a definition of what technology is to be implemented on the NNI. Deployment decisions remain under remit of RIM and RSO, or subject to policy decisions, i.e. outside of the Tier 1 standards. The standards would however mandate minimum requirements to support Interoperability once the decision is made. After feedback received during the 2024 engagement on these standards, DTCT’s definition was proposed to be broadened and now includes the radio systems necessary to support the data transmission required to achieve the Interoperability objectives of the DTCT.

2.4.3 Elements not initially part of DTCT

The application of the proposed definition of DTCT excludes the consideration of the following items for inclusion in this initial set of Tier 1 mandatory standards as it is expected that Interoperability can be achieved without standardisation at national level.

Note that a national harmonisation of some of these may improve the overall productivity of the rail sector (mostly for RIMs) and may be included in Tier 2 standards in the future. However, it is expected that Interoperability can be achieved without such harmonisation.

- Other proprietary train control technologies or products (e.g. Communication Based Train Control CBTC, etc).
- Equipment to Equipment interfaces not covered by interface specifications within the TSI, despite initiatives in EU and/or worldwide to standardised them, e.g. interfaces covered by EULYNX initiative.
- (Traffic Management Systems) TMS-TMS interfaces.
- Power supplies for DTCT assets.
- (Infrastructure side) Fixed telecommunication subsystems beyond what is considered within the CCS TSI.
- Electronically Controlled Pneumatic Brake systems.
- Energy Management Systems.
- Timetable management function pre-day of operation.

As already identified during 2024 engagement NTC acknowledges that operating rules and procedures in force on the NNI can have a significant impact on achieving interoperability. This analysis and the future standard will only focus on the operating requirements related to DTCT without which Interoperability cannot be achieved. Broader harmonisation of Operating rules and procedure (beyond what is required to achieve Interoperability) is left to other initiatives within the NRAP program, hence outside of the content of these standards.

These 2 standards will contribute to a consistent use of the DTCT across the NNI which will in turn become a driver to further harmonising operating rules and procedures where relevant.

2.4.4 Other considerations

DTCT onboard components need a radio link to exchange data with their trackside counterparts. This radio link need to be accessible on each network to both the DTCT Onboard or DTCT Trackside. It is not intended to follow the approach taken in Europe and mandate a given radio technology to be implemented consistently across the NNI. As such the standards will not mandate a given technology for the radio trackside subsystems (i.e. the technology for the radio networks).

In absence of a single technology, RIMs will either have to connect their DTCT equipment to multiple radio networks which offer coverage over their infrastructure, or DTCT onboard will need to have the capability to connect to, and switch from one radio network onto another using different technologies.

A possible approach for these standards (discussed in more detail in section 5.5.4) is to agree on a common set of technology(ies) to be implemented as part of the DTCT onboard to rationalise investments on trains and protect existing trackside investments. This could then give options to RIM willing to rollout DTCT trackside on their network to select from the radio technologies compatible with the ones already installed on the Interoperable fleet, or request for the standards

to consider additional technologies. However, the standard will define mandatory minimum requirements for RIM selecting to implement FRMCS Trackside.

Unlike the latest CCS TSI, it is not proposed to initially mandate the use of ATO over ETCS (AoE) subsystem on the NNI. However, it is proposed to define mandatory requirement (i.e. complying with relevant requirements of the CCS TSI) for RIM selecting to implement ATO Trackside (for example to support driver advisory or semi-automated operations) on the areas of their networks which form part of the NNI. Consideration may be given in the future to include ATO Onboard as part of a Tier 2 standard.

The consideration of “conventional” signalling as part of the standards is proposed to remain limited to the aspects which could have a direct impact on achieving the Interoperability objectives.

The consideration of Network Control / Traffic Management Systems as part of the standards is proposed to remain limited to the aspects which could have a direct impact on achieving the Interoperability objectives.

2.4.5 DTCT Context Diagram

Elements considered for inclusion within scope of the standards and discussed in previous sections are represented graphically in Figure 5 using the same structure as in Figure 4 to facilitate the comparison against the architecture considered by the CCS TSI.

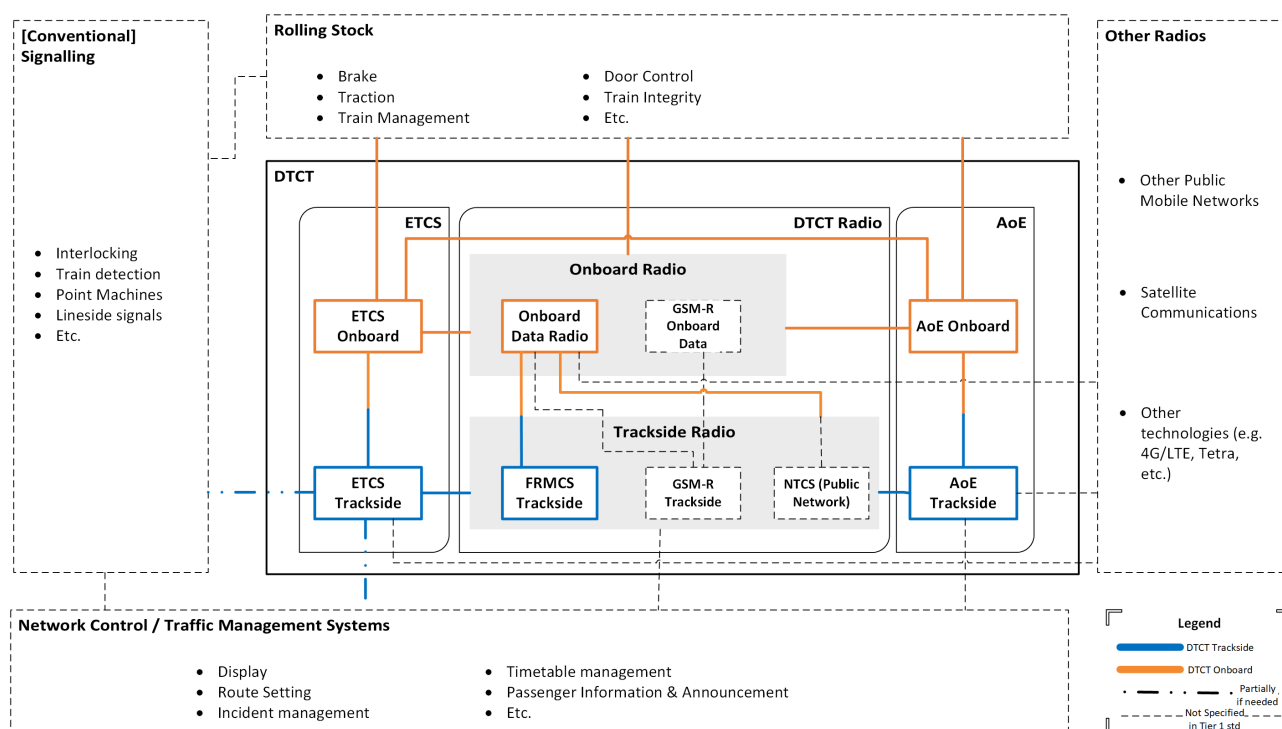


Figure 5. Proposed limits of DTC for use in the standards and their coverage by DTCT Trackside and DTCT Onboard standards



Question 1: Are there any change to the definition of Interoperability and DTCT you would like to be considered for the Australian context?

3 EU Interoperability framework

3.1 High-level Interoperability framework in EU

EU Interoperability framework is defined at its highest level by 3 main Directives/Regulations which sets the framework within which the eight functional and structural subsystems of the railways are managed by their specific Technical Specifications for Interoperability (TSI), as illustrated in Figure 7.



Figure 6. Legislative context defining the framework for Interoperability in EU

The framework provides the regulatory context, common tools and coordination mechanism by which the TSIs are applied and the technologies deployed progressively across EU.

Note: In the EU context Rail Infrastructure Managers (RIM as defined in RSNL) are named Infrastructure Managers (IM) and Rollingstock Operators (RSO as defined in RSNL) are called Railway Undertaking (RU). Despite the differences between the 2 contexts, this paper uses the terms RIM and RSO to improve readability even when referring to EU legislations.

Table 2 provides a summary of the EU directives and regulations establishing the framework. It only focuses on the aspects relevant to the management of the TSI and in particular the CCS TSI.

Legislative element	Relevance for the context of these standards
Interoperability Directive (2016/797 as amended)	It establishes the conditions to be met to achieve interoperability within the Union rail system in a manner compatible with Directive (EU) 2016/798 in order to define an optimal level of technical harmonisation. Those conditions concern the design, construction, placing in service, upgrading, renewal, operation and maintenance of the parts of that system as well as the professional qualifications of, and health and safety conditions applying to, the staff who contribute to its operation and maintenance. This directive defines the subsystems, either structural or functional, forming part of the railway system of the European Union. For each of those subsystems, the essential requirements need to be specified, and the technical specifications determined, particularly in respect of constituents and interfaces, in order to meet those essential requirements (including safety, reliability and availability, technical compatibility, etc.). This directive also defines processes for the management of the TSI, including their maintenance, evolution, temporary error correction, non-application, need for conformity assessment, requirement for placing vehicles on the market, requirement for placing infrastructure in service, etc. It additionally defines the requirements for the independent assessment bodies which represents a key foundation to the later cross acceptance amongst different RIM and RSO of the results of their analysis (as supporting evidence for infrastructure or vehicle authorisations). Importantly, it also contains definition of terms used in the different underlying TSI.
Railway Safety Directive (2016/798 as amended)	It sets-up a common framework (“Common Safety Methods”) so that safety analysis and demonstration are performed in a way acceptable to all member states. It also sets up common targets so that residual safety risks are reduced over time, and safety performance of Interoperability constituent are acceptable to all member states. This is deemed a key foundation to the later cross acceptance amongst different RIM and RSO. These targets have been key to derive CCS TSI and apportion individual targets to each of its components. This directive does not apply to suppliers when developing their products. They follow EN50126 which is deemed by CCS TSI as an acceptable means of compliance to the risk assessment process and targets defined in the directive. These targets are expected to be acceptable to justify So Far As Is Reasonably Practicable (SFAIRP).

Legislative element	Relevance for the context of these standards
	This directive has a much broader scope including the definition of minimal requirements for RIM/RSO Safety Management Systems.
Regulation on EU Agency for Railways (2016/796 as amended)	Establishes the EU Agency for Railways (ERA) and define its tasks with respect to contributing to the interoperability and safety objectives defined above. It establishes the ERA as the system authority which manages in coordination with the rail sector (Suppliers, RIM, RSO, Notified Bodies, Safety Authorities, etc.) the maintenance and the development of the TSI, inclusive of ▪ Inclusion of new functions, ▪ Correction of errors ▪ Issuing of technical opinion for correction of errors in the published TSI. ▪ Issuing guidelines and other non-binding documents facilitating application of railway safety and interoperability The ERA currently acts as the entity issuing EU wide authorisation for placing vehicles into service (inclusive of its CCS Onboard components). ERA also issues ERTMS Trackside approvals, which is now included as part of the application file for an authorisation for placing in service trackside CCS subsystems.
Other legislative elements	These include legislation specific, or not, to railways and governing EC Certification, Defining procedures/modules for Conformity Assessment (e.g. Decision 768/2008/EC, Decision 2010/713/EU, Regulation (EU) 2018/545 etc.), Harmonisation of standards in EU, etc. Further assessment will be required are some of these are called by the TSI.

Table 2. Summary of the EU Directives and regulation relevant to managing interoperability of DTCT

This stage of the project focuses on the applicability of the Control-Command and Signalling TSI (CCS TSI) as well as key dependencies from other TSI, in order to scope content of the Tier 1 mandatory standards. However, it can be observed from the description of the EU framework above, that care will be required when referring to, re-using or transposing the TSI or part thereof into the future Tier 1 mandatory standards. Additional analysis will be required at later stages to understand in more details the possible interdependencies between the standards and the EU framework.

Table 3 provides the list of the 11 Technical Specifications for Interoperability, included in the EU framework. The last column represents the existence of a relationship between the CCS TSI and each of the others. All TSIs, including CCS, assume that the rest of the railway complies with other relevant TSIs, meaning that TSI are dependent on aspects of the railways which are covered by other TSI.

The details of these dependencies will be explored further in the rest of this document (See section 5.5.2 for more detail).

TSI Acronym	TSI Title	Relevant for CCS
TSI OPE	Operation and Traffic Management TSI	Yes
TSI ENE	Energy TSI	Yes
TSI INF	Infrastructure TSI	Yes
TSI Loc& Pas	Rolling Stock - Locomotives & Passengers TSI	Yes
TSI WAG	Rolling Stock - Wagons TSI	Yes
TSI SRT	Safety in Railway Tunnels TSI	Yes (Indirectly through RS TSI)
TSI CCS	Control Command and Signalling TSI	Yes
TSI NOI	Noise TSI	No
TSI PRM	Persons with Disabilities and with Reduced Mobility TSI	No
TSI TAF	Telematics Applications for Freight service TSI	No
TSI TAP	Telematics Applications for Passenger service TSI	No

Table 3. List of EU TSI and relevance to this assessment

3.2 Control-Command and Signalling TSI

The CCS TSI is implemented into EU legislation in the form of a Regulation. It defines obligations to “Member States”, RIM, RSO, CCS Onboard suppliers and CCS Trackside Suppliers, independent assessment bodies, as well as to the ERA. As for all the TSI, the CCS TSI only specifies the minimal requirements the CCS subsystems need to comply with in order to achieve the essential requirements set for the European railways by the Interoperability Directive.

The CCS TSI is structured in a similar manner to the other TSI with its main body making reference to Annex I, where most of the content is defined.

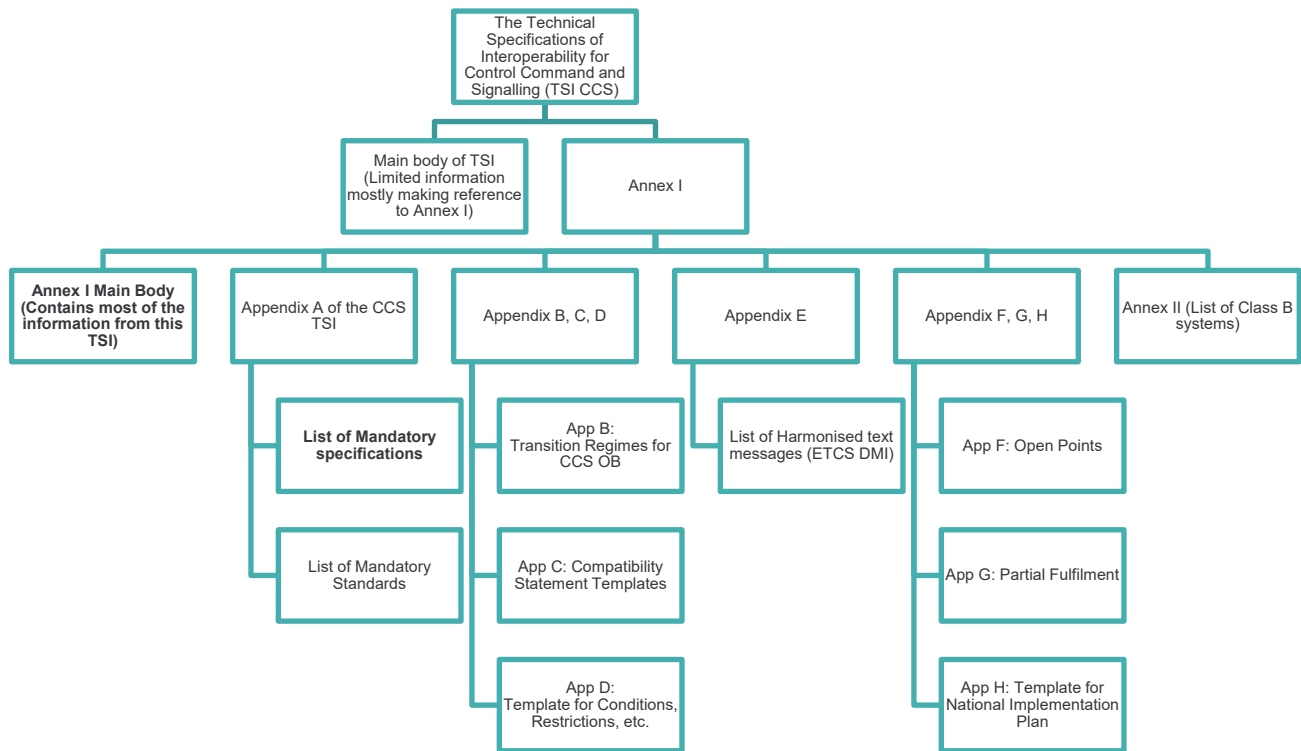


Figure 7. CCS TSI document structure overview

The main body of Annex I of the CCS TSI describes:

1. Introduction. Current CCS TSI makes mandatory the implementation of CCS onboard to locomotives and passenger rolling stock as well as some special vehicles (used for rail maintenance and construction). CCS trackside is now mandated well beyond the initial remit for high-speed lines only.
2. Subsystem and functions, covers ETCS, Railway Mobile Radio (RMR) and [Semi-]Automated Train Operation (ATO) and include the following functions:
 - Train protection.
 - Voice radio communication.
 - Data radio communications.
 - Train detection.
 - [Semi-]Automated Train Operation (Including Driver Advisory functions).
3. Essential Requirements. Lists and demonstrate how this CCS TSI contribute to achieving the “Essential Requirements” defined by the Interoperability Directive (including safety, health, environment protection, technical compatibility and accessibility.)
4. Characterisation of the subsystem (technical requirements). It covers all the mandatory requirements needed for each of the subsystems, their interoperability constituents, as well as the relevant internal and external interfaces. Most of the requirements refer to the ERTMS specifications published by the ERA, and their applicable versions are listed appendix A of this Annex I of this TSI.

This chapter additionally defines the harmonised mechanism to manage local exception and requirements for specific ETCS and Radio Systems Compatibility (ESC/RSC).

5. Interoperability Constituents (IC). IC means any elementary component, group of components, subassembly or complete assembly of equipment incorporated or intended to be incorporated into a subsystem, upon which the interoperability of the rail system depends directly or indirectly, including both tangible objects and intangible objects. The definition of the IC is critical for the modularity thought through the TSI to improve re-usability and efficiency.
6. Assessment of conformity or suitability for use and 'EC' verification. This proposes a modular approach to the overall verification of the subsystems as is built up progressively based on the verification and prior conformity assessments from its IC, as well as the project specific aspects (for Infrastructure and vehicles). ESC and RSC are not required for the certification of the subsystems but are required to be demonstrated as part of the OPE TSI prior to an RSO operating for first time on a given network.
7. Implementation. This chapter defines at length when it becomes mandatory to rollout compliant CCS and when not for greenfield, brownfield, new assets, upgrade, retrofit, maintenance, etc. It also covers how changes to the TSI are to be implemented as well as the correction of errors in the TSI as published from time to time by the ERA.
This section additionally officialises the special cases reflecting some of the legacy issues faced by RIMs (e.g. trackside train detections).

The CCS TSI does heavily reference different aspects of the Interoperability Directive, Safety in Railway Directive, ERA Regulation and other rail and non-rail directive. It also produces outputs and uses inputs in its defined processes which are managed within "registers" coordinated by the ERA.

(CCS) TSI, cover aspects required to achieve Interoperability which extends well beyond the technical requirements managed by the ERA and already in use by the different projects in Australia.

Its main aspects can be summarised into 3 topics:

- Technical & Operational Requirements and definition of the system (CCS).
- Certification and conformity assessment requirements.
- Implementation policy (Over time, project, corridors and vehicles)

At this stage NTC's intention is not to manage implementation policy as part of the mandatory standard. Further discussion and feedback on the first 2 topics are included in following sections of this document.

CCS TSI approach to mandatory requirements

As written in Annex I chapter 4.1.2, "[The CCS] TSI is based on the principles of enabling the Control-Command and Signalling Trackside Subsystem to be compatible with TSI-compliant Control-Command and Signalling On-board Subsystems. To achieve this goal:

1. functions, interfaces and performance of the Control-Command and Signalling On-board Subsystem are standardised, ensuring that every train will react in a predictable way to data received from trackside.

2. for the Control-Command and Signalling Trackside Subsystem, track-to-train and train-to-track communication are fully standardised in this TSI. The specifications referenced in the points below allow Control-Command and Signalling trackside functionality to be applied in a flexible way, so that it can be optimally integrated into the railway system. This flexibility shall be exploited without limiting the movement of vehicles with TSI-compliant on-board subsystems.”

This approach with a very high level of prescription for the CCS onboard subsystems and for the interface between the onboard and trackside subsystems is unavoidable in the context of a complex, operational and safety critical technology. Indeed, it would not be possible for RIMs and their supply chain to implement their trackside subsystems and configure them for the needs of their networks without absolute certainty of the behaviour of the initial and future vehicles operating on their networks.

Conversely, this means that CCS TSI offer some extended flexibility to the RIM so that they can configure their application of ETCS to best suit the needs of their existing railway while remaining fully compliant with the TSI. Application can be configured to suit different operating context (e.g. high speed, commuter, freight, etc.), engineering rules, signalling principles, and support retrofitting of ETCS over existing lines or installation on new ones.

3.3 UK approach to complying with European framework post Brexit.

The UK remains committed to implementing ERTMS even after its exit from the EU. This can provide useful lessons to Australia with respect to implementing the CCS TSI, outside of the EU Interoperability framework. It is worth noting however that the legislative starting point in 2025 Australia is different to where the UK was in 2020.

In 2020, the UK already had rail specific legislations which aligned to the interoperability framework defined in the 4th Railway Package (2016). UK has opted to create the National Technical Specifications Notices¹ (NTSN) which individual scopes align with the 11 TSI.

Currently, the structure of the NTSN is intentionally broadly aligned with the content of the TSI, acknowledging that the supply chain and the suppliers in particular, will be familiar with the TSI, and that similarity in content and structure of the information may improve productivity. Some elements have however been reworded to reflect the overall British legislation, standards, and implementation policies.

From a project point of view this approach makes the change of referential (UK vs EU) almost transparent. It does however introduce complexity and effort to manage such referential.

RSSB has started to engage with stakeholders from the industry about the evolution of the NTSN, and the benefit to split or keep together the Technical Requirements, Conformity Assessment Requirements and the Implementation policy for both the infrastructures and the vehicles.

¹ <https://www.rssb.co.uk/standards/types-of-standards-and-how-they-work/national-technical-specification-notices>

3.4 Achieving a truly interoperable railway: lessons learnt

With over 20 years of ETCS deployments, there is an opportunity to learn from Europe's experience and avoid repeating the same mistakes by drawing on the lessons they have learned.

In the course of compiling this document, subject matter experts were consulted from prominent European jurisdictions on their approach to and experience in ensuring ETCS interoperability. This includes:

- The Danish signalling programme - the first national-scale ETCS deployment in a European country.
- The United Kingdom, which, despite exiting the EU is still continuing with ETCS as its technology of choice but, like Australia, is not necessarily bound by the full suite of EU requirements. It is worth noting however that the legislative starting point in 2025 in Australia is different to where the UK was in 2020.
- SNCF – one of the largest ETCS deployment in Europe and currently involved in the research & development programs relevant to these standards.

Experts consulted reflected on their own country's efforts and experience of interoperability, as well as the broader experience across the EU.

The following provides a summary of key points made in the interviews and collected after review of recent literature:

1. It is essential for Onboard products and subsystems to rigorously comply with the specifications.
2. Independent assessment and independent certification of compliance of the products and subsystems is essential.
3. Trackside subsystems by design have more flexibility; flexibility offered for the configuration of ETCS trackside application has enabled the acceptance and adoption of the technology by largest the RIM in Europe, even outside of the corridors where ETCS is mandated in law.
4. On the other hand, there is a growing acknowledgement of the rail sector that the wide range of configurations is increasing the complexity of the portfolio of solutions managed by the supply chain, creates barrier to entry into some markets, and create avoidable overhead for RSOs in integrating their onboard subsystems, and in developing and maintaining competency for their staff.
5. The deeper the harmonisation of outcomes is required (i.e. moving from technical to operational harmonisation), the more it is essential to develop common principles for the trackside subsystems to pre-empt configurations for ETCS and non-ETCS assets. This can take multiple forms, for example Operational Specification / scenarios, engineering rules, signalling principles, reference designs, but the greater the harmonisation is required the more details and assurance is required.
6. Harmonising operational outcomes is highly recommended. Aim for a common core, but consider variances or branches if justified by the operating context.
7. Managing compatibility over time requires entities with competent staff to act System Authority for the system under consideration.
8. The approach implemented in the National Technical Specification Notices in the UK has proven to be workable but introduced circa 1 year offset to reflect changes in EU baseline.

9. Changes to onboard subsystem requirements (e.g. upgrade to new baselines) are long and often onerous to implement. It is essential that national standards seek to provide visibility and certainty of investment for RSO.
10. It is essential that changes to national standards, with an impact on assets already in service, consider cost vs benefits for such changes.

Furthermore, there is the opportunity to draw upon Australian experiences of ETCS deployment over the past 15 years. ETCS implementation by kilometre of track and number of trains in service across Australia places us within the top 10 users globally of ETCS². Australian applications have included pioneering configurations of the technology with multiple suppliers and versions of their products, while also having faced already the fact their railways and vehicles do not comply with the European referential.

The NTC encourages stakeholders having been involved in past and current DTCT implementation in Australia to share the lessons they learned for considerations for the scoping and future development of these standards.



Question 2: Do you foresee any of the lessons learnt to be particularly problematic for Australian railways?

² <https://www.ertms.net/facts-figures/deployment-statistics/>

4 Australian railway context

4.1 The rail network and railway entities

Australia's rail network is made up of is a mixture of standalone and interconnected networks, which are managed by 15 different Rail Infrastructure Managers (RIMs). 11 of these networks are connected, and trains often need to travel across multiple networks to complete a journey – including journeys between the mainland state capitals. Seamless travel across these networks is essential to ensure an efficient and reliable service to customers.

The National Network for Interoperability (refer to Section 2.2) includes some or all of the networks owned or managed by eight (8) different RIMs.

There are over 30 different Rolling Stock Operators (RSOs) that operate trains across the NNI. These include:

- Large commercial operating entities
- Small commercial operating entities
- Government-owned rail operations (primarily passenger operations)
- Heritage operations (primarily small and volunteer-based entities)

Depending on the network, operations can be vertically separated (i.e. above rail operations are managed by a different entity to the network owner), vertically integrated (above rail operations are managed by the same entity as the network owner) or a combination of both.

4.2 Railway oversight in Australia

Australian railways are managed under a co-regulatory structure, whereby industry develops and administers its own arrangements, but government provides legislative backing to enable the arrangements to be enforced. The most pertinent law relating to rail operations in Australia is the Rail Safety National Law (RSNL), which mandates a common framework for rail safety management that must be complied with by all RIMs and RSOs. Key management documents required by the RSNL include a Safety Management System (SMS) relevant to the RIM / RSOs' operations, and Interface Agreements that sets out the means of managing interfaces between the RIM / RSO's activities and other interfacing entities. The format, content and details of these plans are the accountability of each entity.

As a result of both the recent Rail Safety National Law (RSNL) review and NRAP engagement, amendments to include interoperability requirements in the law are being explored. In the shorter term, Ministers have asked the NTC to progress an amendment to the National Regulations to require an Interoperability Management Plan, to require RIMs and RSOs to consider how their actions impact on interoperability and to ensure that interoperability across the NNI is not compromised.

4.3 Comparison of key items within the regulatory framework between Australia and EU

The regulatory approach in Australia sits (in large part) in contrast with the regulatory framework governing railways in the EU, where the TSIs apply. Table 4 provides a summary of key differences that must be considered in relation to the applicability in Australia of requirements that exist under the European Union TSI framework, specifically considering the application of ETCS.

Area	EU approach	Australian approach
Standards	The European Union has mandated the application of the TSIs on each national railway. The TSI sets out minimum requirements for interoperability only. Each railway sets standards for issues beyond the TSI, e.g. signalling principles...	Each rail entity is accountable for their own standards, and for justifying that they are appropriate for their network. Note – some standards have been aligned through historical reality or by agreement of RIMs – for example track gauge, loading gauge, etc. However, at present and historically this does not apply to signalling standards.

Area	EU approach	Australian approach
Safety management	The Interoperability framework in EU include Railway Safety Law, which obliges railways to • have Safety Management Systems, • Have frameworks in place in their SMS to manage safety risks which comply as a minimum with the requirement from the Common Safety Methods-Risk Assessment (CSM-RA) • Define minimum level of acceptability (“Common Safety Targets”) and harmonised reporting to allow supervision and consolidation of safety performance across the EU. ERA is delegated responsibility to coordinate and supervise the application of the Railway Safety Law, and is also delegated authority to certify compliance of SMS from RSO (Single safety certificates) in coordination with other National Safety Authorities	Each rail entity has an obligation under RSNL to ensure that its operations are safe So Far As Is Reasonably Practicable (SFAIRP). This includes ensuring that their standards effectively mitigate risks related to their operation, and that tools and techniques are appropriate.
ETCS deployment	Under EU law, all conventional (freight, commuter, intercity) and High-Speed corridors require progressive implementation of ETCS unless not economically viable (e.g. for upgrades, etc.). The CCS TSI states that Member States shall draw up National Implementation Plans (NIP) describing their actions to comply with the CCS TSI, setting out the steps to be followed for the implementation of fully interoperable 'control-command and signalling' subsystems.	Each railway has the accountability and prerogative to determine whether it will deploy ETCS on its network, and the relevant timing of any deployment. Fitting ETCS to a network will only be effective if the RSOs operating over that network also fit ETCS to their locomotives.

Area	EU approach	Australian approach
Funding	Accompanying the mandate to fit ETCS, the EU has made funding available to complement the member states and railway undertakings own funding to support deployment of systems compliant with TSI.	Each RIM must secure its own funding for any works, which is normally achieved through a business case process. A framework for cost and benefit sharing, to support the fitment of the national locomotive fleet (owned by many different RSOs) is under development but yet to be agreed.
System Authority	The European Rail Agency is the legislated System Authority for CCS and its specifications. RIM remains the authority over their deployed assets	Each RIM is the system authority for their own network, and each RSO is the system authority for their own trains.

Table 4. Comparison of key differences in the EU and Australian rail regulatory frameworks

5 Technical Requirements for Interoperability

The approach taken for the assessment of the technical interoperability requirements (this section) and the recommendation for inclusion in these standards includes multiple considerations which have been applied by decreasing order of precedence:

1. Focus on requirements necessary to achieve Interoperability objectives.
2. Adopt in first instance the requirements already specified in the TSI in order to benefit from global supply chains and avoid the need to develop bespoke products dedicated to the Australian market, with the risks associated.
3. When not possible, keep the onboard subsystems as standard as possible, where any non-standard feature required to achieve Interoperability should only be allowed, if beneficial at NNI level.
4. When not possible, propose solutions which:
 - do not compromise the de facto technical compatibility offered by the technology,
 - can be implemented consistently across the NNI and the impacted fleet.

5.1 Alignment with the CCS TSI

Alignment with the CCS TSI is the fundamental underpinning to achieving interoperability of ETCS installations – noting as well that EU experience is that this is necessary but not sufficient. However, there are a range of questions in relation to the applicability and management of the TSI for application in Australia, which are addressed in the sections below.

5.1.1 Applicable version of CCS TSI

The CCS TSI mandates the implementation in EU of the most recent version of CCS/ERTMS subsystems, which in the current version of the TSI (2023) is as follows:

- ETCS Baseline 4 Release 1 (B4R1)
- RMR:
 - GSM-R Baseline 1 Maintenance Release 1 (B1MR1)
 - FRMCS Baseline 0 (B0)
- ATO: Baseline 1 (B1R1)

The TSI also requires backwards compatibility with previous ETCS baselines, extending back to Baseline 2, from 2006.

The next release is foreseen to be mandated in Europe by 2027/2028, which will update these requirements.

The projects underway in Sydney and Brisbane are both applying the previous to current version of ETCS i.e. Baseline 3 Release 2, or B3R2 (2016). The version of ETCS currently in service on the NNI (ETCS L1 in Sydney) is B3R1.

The initial approach taken by the EU was to issue TSI so the specification of new onboard subsystems makes them backward compatible to older versions implemented trackside. This allowed new trains equipped with the latest version to be compatible with trackside already in service and also allowed already equipped trains to not have to be updated to comply to the new versions of the TSI once released (unless trackside required so).

The approach also offered functions to the trackside subsystems (Management of “System Version”) so that they could:

- Select to only used functions already available and compatible to onboard from older baselines.
- Select part of the new functions, for which the specifications guaranty they will not create technical incompatibility with trains equipped with older version. Albeit these trains may just disregard the new functions and this needs to be acknowledge and considered by the RIM.
- Select all function acknowledging that this may preclude trains equipped with older version from being able to operate under ETCS on those networks.

As a consequence, infrastructure used by large fleets of different ETCS implementation periods were expected to cover most of the historical CCS version of vehicles to operate on their network and almost forced to take an approach driven by the lowest common denominator.

The EU experience has shown that complexity kept increasing for RIM as well as the effort to manage the configuration of the railways at the same time. The latest TSI now proposes a new approach whereby vehicles are given a transition period to update their subsystem in order to correct error (potentially impacted nominal operation) which could be detected in the early stages of the implementation of latest version of a TSI and ahead of the next formal release. It has also legally removed the possibility to keep using onboard subsystem complying with the initial TSI (setting a limit to the maximum backward compatibility which will be supported by the specification and products).

It is proposed that the standards mandate:

- The minimum baseline for new DTCT onboard systems to be implemented beyond a certain date. This could typically be set to the latest published in Europe, if decided so by the entity governing the standards.
- The oldest baseline DTCT Onboard systems can implement to achieve Interoperability across the whole NNI.
- That RIM implement DTCT Trackside baselines (and System Version) on areas of their network belonging to the NNI, so that they ensure the oldest allowed onboard system baseline can achieve Interoperability.

This is consistent with the approach used recently in Europe but gives Australia the opportunity to control what is to be mandated on the NNI, refraining from the latest versions if these do not add value to the Interoperability on the NNI.

This approach also gives Australia a tool to protect investments on the trains and the infrastructures controlled through “DTCT Onboard oldest baseline”. Raising this oldest baseline allowed in the future would be managed through an update of the standard, which will be subject to the governance proposed and summarised in section 7 and as consequence the funding required would be analysed and considered at the same time.

During the development phase of the standard, further analysis and consultation will be performed to determine in more detail the trigger date for new trains beyond which the minimum version is to become mandatory. This could cover for example, from the contract date to when the first of class vehicle or the latest vehicle of the fleet is commissioned, etc.

The application of the above approach in 2025 would lead to (for illustration):

- The minimum baseline for new DTCT onboard systems to be ETCS B4R1.
- The oldest baseline DTCT Onboard systems to be B3MR1 (as used currently in ETCS L1 lines in service on the NNI) or B3R2 (as currently being implemented in Sydney and Brisbane).

Note: No other projects around the world have currently implemented ETCS Baseline 4 and Australia may decide to adopt new technology baselines with caution. However, B4R1 or later will be required to avoid national adaptation of ETCS products (e.g. B3R2 as currently deployed) to interface with the proposed FRMCS.

5.1.2 Interim update of the TSI (Error corrections)

In Europe, RIM, RSO and suppliers report potential errors to the ERA for analysis and proposal of its resolution if affecting the TSI. All those agreed as errors (i.e. these preventing from achieving EU Interoperability and which originate from a deficiency of the TSI), are prioritised for resolution and have their agreed corrections officially published in the form of a “Technical Opinion” (OPI), in line with EU Interoperability framework. It is then mandatory for onboard subsystems to be updated and implement the corrections proposed in the OPI after a transition period ahead of the next TSI baseline.

It will be necessary to consider the need to mandate, or not, the interim ERTMS error corrections (i.e. the “Technical Opinion”, OPI) released by the ERA from time to time until they are formally published in the TSI.

On the one hand, Australian RIM and RSO will not be part of the stakeholders ERA engages with to define the list of errors to be corrected, so it is possible that some of these errors do not exist in practice on the NNI, and such corrections could be deferred in Australia, to minimise costs of upgrades if unnecessary.

On another hand the suppliers will include these corrections for their standard products in EU and not including them may eventually lead to Australian specifics. From a RIM point of view, mandating the error corrections for the Onboard subsystems makes the management of the configuration on their network less complex.

There is evidence in the EU and Australia that upgrading software (as commonly required to correct errors) can lead to additional changes of the Onboard subsystems installed (e.g. hardware, etc.). However this is reported to be more likely with complete changes of baselines compared to implementing Technical Opinions, which are typically issued few years after the latest baseline it

applies to. The consequences of the decision need to be investigated, and the proposed approach acknowledge the commercial constraints.

The NTC is proposing that error corrections published in Europe are only mandated once decided through appropriate governance and not automatically.



Question 3: Are there any key considerations missing or alternatives that should be investigated on the proposed approach for managing DTCT baselines and error corrections?

5.1.3 Standard ETCS configurable options

As discussed in section 3.2, ETCS is a technology where:

- its onboard subsystems are specified in a very prescriptive manner (and certified once installed).
- The information exchanged between the onboard and trackside subsystems offers multiple options, but the language used to transmit the information and the reaction by the onboard subsystems are specified in detail.

On the other hand, this approach leaves a wide range of configurations available to the trackside subsystems, so that RIMs can select the functions to best fit their network to achieve the targeted performance levels considering their operating and economical contexts.

ETCS can be configured in many ways, but most of these options are enacted through design of ETCS trackside. Several categories of options are available, and the main ones are summarised below:

ETCS Levels:

Three levels are defined, namely Level 0, Level 1 and Level 2.³

The network a train operates on will inform the onboard subsystem of the level in which it is to operate. The selection of such level will then influence the order of precedence for the processing of the different information. The selection of the level is driven by the investment on the infrastructure side, in particular with respect to having a suitable radio network.

ETCS Modes:

A set of operating modes are available for the infrastructure manager and operator to implement, including Full Supervision, Shunting, On Sight, Staff Responsible and others. The activation of these modes is generally triggered from the trackside system (specially for the ones conveying an authorisation to move), although some partially supervised or unsupervised modes can be directly activated by the driver.

³ The former ETCS Level 3 no longer exists and has been merged with Level 2

ETCS Modes are well defined functionally and operationally for the driving modes most commonly used. The technology offers however multiple valid options in some scenarios, particularly for degraded operational contexts (e.g. failure of signalling assets trackside, support to worksite protections, etc.).

ETCS Functions

A range of functions are available, and RIMs can elect to implement some functions or not, and when multiple options exist select which functions are best for them. Functions such as braking to target are widely used (noting that some Limited Supervision implementations do not provide universal braking to target), whereas other functions such as Automatic Train Ahead Free depend on the design choices in each application. Additional examples of ETCS functions are provided below.

Once levels, modes and functions are selected, each message sent to the train will have the information configured for the exact place and applicable principles defined for the network.

Some modes and functions have parameters which can be configured to apply consistently across an area. These common parameters are named ETCS “National” Values⁴ and apply while a train operates within an area with a given identifier (i.e. called “NID_C”). Currently the CCS TSI or TSI OPE do not mandate common and consistent National Values so ETCS is specified to apply the relevant values for the network on which the train is operating on and seamlessly change to a new set of values when changing network. These values often relate to the operating rules and parameters for each network (e.g. safe operating speed for different contexts, maximum distance to set-back, etc.) and local technical rules (e.g. parameters to supervise radio losses, reaction to a loss, etc.).

Lessons learnt from European rollout indicate that while flexibility offers short term merit, there are longer term benefits in possibly harmonising the options selected by RIMs using ETCS, in particular if the problems faced and desired operational outcomes are similar.

Section 5.5, addresses this aspect and the need for aligning some operational and technical practices.

5.1.4 Technical alignment between CCS TSI subsystems

The operation of a large fleet of ETCS equipped trains over multiple networks fitted with ETCS will require the interconnection and coordination of systems long before there are adjacent ETCS implementations (i.e. when Trackside Servers (named Radio Block Centres – RBC) are required to be interconnected to perform “ETCS Hand-overs”). Critical back-office systems include Key Management Systems, which are used to generate, update and distribute encryptions keys and security certificates.

⁴ In ETCS the use of the words “National” or “Country” only represents a Network or part thereof where some properties will be common. The CCS TSI do not mandate that the limit of these areas align with the limits of administrative entities.

Current projects in Australia have not yet addressed interconnections between Key Management Systems, and only a limited number in Europe have done so. Detailed analysis and consultation with rail sector will be required during the development stage of the standards to understand which elements need to be mandated to support security of data exchanges across the NNI to achieve interoperability.

Note that in addition to the technical interfaces between systems, agreements and operating procedures will need to be established between RIMs, even in cases where a railway interface does not currently exist (e.g. between Sydney Trains and Queensland Rail). These operating procedures are not covered by the TSI OPE. A similar situation will arise when interconnecting radio systems at network level (see section 5.4.6).

5.1.5 Optional functions within the CCS TSI

While it is intended that products used on the NNI are as “off-the-shelf” as possible, the TSI offers a very vast range of options, some of which could require investment on trains despite the fact that those functions may never be used by any RIM for areas of their networks on the NNI.

It may be appropriate that the standards explicitly identify options within the TSI, or well contained subsystems (e.g. ATO, etc.) which are foreseen not to be used on the NNI, and as such should not be part of the mandatory requirements for vehicles (which, in effect, would be contrary to the TSI).

Several approaches could be considered where the standards could:

- Explicitly exclude the use of such function:
Infrastructure subsystems or onboard subsystem of any vehicle operated on any part of the NNI shall not implement such function.
- Identify some functions as optional:
Meaning that entities could not rely on any or all other entities having that option implemented to design and assure their subsystems. The options could still be implemented on part of the NNI or the fleet, but it shall not prevent others not implementing it to achieve Interoperability.
- Identify functions as mandatory:
All infrastructure on the NNI or the fleet shall implement such option.

Further discussion related to this matter and the scope to which each of the future standards will apply to are addressed in section 5.6.

Table 6 provides some initial considerations for inclusion or exclusion on the NNI for some of the key optional functions or subsystems.

Subsystem impacted	Functions/subsystems and proposed approach (for discussion)	Notes
ATO	ATO Onboard <u>Not Mandatory</u> (as part of this standard)	As already mentioned in section 2.4, It is not intended initially mandate installation of ATO Onboard assets, unlike currently mandated in the CCS TSI. Note that it may be beneficial for ATO Onboard to be included in a Tier 2 standard in the future, applicable only to RSO implementing ATO Onboard.
	ATO Trackside <u>Mandatory</u> (only for RIM implementing this function)	As already mentioned in section 2.4, It is not intended initially mandate installation of ATO Trackside assets, but RIM installing ATO Trackside along with ETCS Trackside will be mandated to comply with relevant requirement from CCS TSI.
Rollingstock	Interface Specification for Trackside Train Detection mandated in the CCS TSI (ERA/ERTMS/033281): <u>Not Mandatory</u> (as part of this standard)	The compatibility between vehicles and trackside train detection is already being managed in Australia and is not intended to form part of the Tier 1 standards. Most of the products for train detection used in Australia comes from global suppliers which will be design for such compatibility, so it may add productivity in the future if new vehicles were to comply with this specification (if proven to be compatible with existing Australian requirements). As such it may be valuable to consider such topic for a Tier 2 standard.
ETCS	Radio Infill: <u>Not mandatory</u> or <u>Excluded</u> for onboard subsystems.	This function is optional in EU, has been rarely used worldwide and is only supported by limited onboard suppliers, while requiring the use of GSM-R.
	Euroloop: <u>Not mandatory</u> or <u>Excluded</u> for onboard subsystems	This function is optional in EU, has been rarely used worldwide and is only supported by limited onboard suppliers.

Subsystem impacted	Functions/subsystems and proposed approach (for discussion)	Notes
	Possibility to retain legacy (called "Class B") train protection on the NNI requiring Specific Transmission Module (STM) on the vehicles: <u>Not mandatory</u> or <u>Excluded</u> for onboard subsystems	It is not intended that vehicles operating on the NNI would require in the long term the installation of other form of onboard DTCT than ETCS. Locomotives operating on the NNI today have no form of in-cab signalling. Standard would recommend such approach even outside of the NNI.
	Management and distribution of Encryption keys and security certificates across the NNI and impacted fleet	To be assessed at later stage.
ETCS Rollingstock	Are there ETCS-RS interfaces which should be made <u>not mandatory</u> for onboard subsystems?	There are a number of functions where ETCS trackside could activate orders on the train to be executed automatically if the functions are available, mostly regarding electrical traction supply.
	Should the ETCS-RS interfaces mandate the use of dedicated service brake interface and dedicated traction cut-off interface? Or leave this decision to each RSO?	The 2 interfaces remain optional in the TSI from an onboard point of view. However, their presence or absence do have an impact on the infrastructures as they can impact the minimum brake performance to be considered for design.
Radio	Use of dedicated interfaces between ETCS Onboard and Onboard Radio, or dedicated onboard transponder antennas to support radio functions (e.g. enhancing position information for other purposes than ETCS) <u>Not mandatory</u> for onboard subsystems	While not expected, it is unclear at this stage if the routing from one radio infrastructure to another for data transmission purposes, may require some form of enhanced positioning.

Subsystem impacted	Functions/subsystems and proposed approach (for discussion)	Notes
	Mission critical voice functions are not proposed to be delivered as part of the DTCT on the NNI: <u>Not mandatory or Excluded</u>	Excluded from mandatory standard at the moment.
	GSM-R Onboard: <u>Not mandatory</u> for onboard subsystems	See detailed argument in section 5.4.5. It is not intended initially to mandate installation of GSM-R Onboard assets on new deployment of DTCT, unlike currently mandated in the CCS TSI.

Table 5. Possible optional functions for inclusion and exclusion



Question 4: Should the standards identify functions within the CCS TSI that are not to be used in Australia or on the NNI, if agreed at national level?

5.2 Tailoring of CCS TSI

The following sections discuss the management of possible deviations in Australia from the mandated TSI. As explained below, some deviations appear inevitable and will need to be managed so that they do not put the interoperability across the NNI at risk.

Irrespective of the specific topics, there are multiple approaches to the definition of the standards and the purpose they achieve:

- DTCT standards mandate the minimum requirements, providing a baseline of acceptable deviations (or lack thereof).
- DTCT standards mandate the compliance to minimum requirements which could be managed outside of the standards, offering possibly greater flexibility and efficiency to manage changes and adapt to new context. The definition of this outside-of-standards minimum requirements would remain subject to due governance.
- DTCT standards define the areas which constitute permitted deviations and mandate that approval is requested from the National governance function on a case-by-case basis.
- A hybrid of the approaches described above.

The approach agreed would be applied within the framework in place for governance of the standard and its application, and to manage non-compliances and concessions.

These aspects are discussed in more detail in Section 6.

The consequences of customisations on the ability to achieve interoperability can vary greatly depending on the nature of the change, and whether the modifications happen solely on the onboard subsystem or trackside subsystem, or both. The CCS TSI includes guidelines to assess the impact that any modifications could have on the technical compatibility between an ETCS trackside and an ETCS onboard subsystem.



Question 5: Are you aware of any existing non-compliant functions that could impact interoperability of networks if not incorporated into the standards?

5.2.1 ETCS parameters beyond defined values

The TSI include a range of configurable parameters, intended to allow each railway to implement ETCS within an acceptable bound of variation to suit local requirements (as discussed in section 5.1.3). However, some of the existing ETCS implementations in Australia have already found it preferable to redefine values of variables or messages which are not intended to be configurable within the onboard subsystems in the ETCS Specifications. This includes, for example, redefining the “fixed values”, “default national values”, the text to be displayed on the onboard ETCS DMI for the “system messages” (i.e. not sent by the trackside), or inhibiting some modes, levels or DMI menus not used on the network these trains are meant to operate on.

Each of these non-compliances are generally supported by a sound rationale and in some cases SFAIRP justifications at network level. They are currently applied to vehicles which only operate within a single network (even if areas of this network are on the NNI).

The implementation of these changes are supplier specific which makes it difficult to ascertain how products from other suppliers will behave, but changes are typically coded in the ETCS onboard software once and for all, i.e. they will remain the same irrespective of the network the vehicle is operating on and cannot change and adapt to the network it is on (as distinct from ETCS National Values).

The danger of allowing RIMs to customise ETCS on their networks, if these modifications require modification of the onboard subsystems, is that ETCS Onboard will become more and more complex and that initial modifications will lead to additional cost every time:

- A new fleet is installed.
- A new ETCS supplier (not yet having implemented the function) supplies equipment (possibly leading to uncompetitive advantages to incumbent suppliers), or
- Products are upgraded to a new ETCS baseline.

Not all local customisation of the CCS TSI have taken form of a software modification of the ETCS onboard subsystems. Indeed, the majority of implementations of ETCS in Australia have only assumed in their trackside designs the installation of ETCS onboard subsystems and the performance of the trains for which they had funding for. This mean that the trackside arrangement may have been over optimised and could now impose restrictions on the acceptable tolerances defined in ETCS Subset-40 (“dimensioning & engineering rules”) and ETCS Subset-41

(“Performance requirement for interoperability”) or may require upgrade when new ETCS fleets are introduced.

As an example, the positioning of switchable balises in Sydney’s ETCS Level 1 deployment has assumed a narrower range of distance from the front axle to the onboard antenna than is specified in the TSI, in order to minimise expensive reworks on existing signalling assets. At the time the decision was made only the Sydney captive electric fleet was to be fitted and allowed for, and no 3rd party trains were expected to be fitted with ETCS to operate on the network.

Some examples where non-compliances are already implemented or may be appropriate in Australia is documented in Table 6. The “proposed approach” shown follows the same approach defined in section 5.1.5 to Exclude, Mandate as optional, or Mandate. This table is not intended to be comprehensive. Additional instances are also provided in section 5.5.1.

Functions impacted	Proposed Approach on the NNI	Notes on deviation already implemented
ETCS Fixed Values	Use of TSI defined values (Or Australia-wide): <u>Mandatory</u> for onboard subsystems.	The current differences are minor and related to legacy operational rules. It is beneficial in the longer term to revert to the values from CCS TSI. <u>For example</u> , TfNSW has modified on its ETCS equipped trains the thresholds used to trigger visual and audible cues when over speeding to align with its current Sydney Trains operational practices.
ETCS Default Values	Use of TSI defined values (Or Australia-wide). <u>Mandatory</u> for onboard subsystems.	This only relate to values used by the trains during very degraded situations, and each ETCS equipped network can adequately mitigate this situation. <u>For example</u> , QR operated passenger Trains equipped with ETCS will use specific Default Values (aligned with the planned “ETCS National Values”) in lieu of the defined ETCS Default Values, to eliminate some degraded scenarios. <u>In another example</u> , NSW used to set the <u>default</u> speed in “ETCS Unfitted” (UN) mode to 160 km/h instead of 100km/h to manage the migration phase when implementing ETCS L1. Note that previous studies (Ref 4) showed there could be merit using different values for aspect related to operations of trains outside of ETCS networks to reflect Australian existing operations.

Functions impacted	Proposed Approach on the NNI	Notes on deviation already implemented
DMI “system messages”	Use of TSI defined values (Or Australia-wide): <u>Mandatory</u> for onboard subsystems.	Note: <u>This does not relate to ETCS Text Messages sent by trackside.</u> Configuration if decided by the RSO with their suppliers could be acceptable (e.g. to improve readability) but if customised, values should be agreed and be common across the NNI or be network agnostic. <u>For example</u>, TfNSW has modified its ETCS equipped trains to display some messages in specific configurations or to align their content with defined meaning from the organisation, which does not align with the ETCS Specifications.
Inhibition of functions of the onboard subsystem, not used on one network.	Use of TSI defined values or conditions. <u>Mandatory</u> for onboard subsystems.	<u>For example</u>, TfNSW has modified on its ETCS equipped trains so that ETCS onboards permanently disable the functions and buttons for the Train Integrity confirmation, the speed/distance setting in ETCS Staff Responsible mode by the driver on the DMI, as not allowed on Sydney Trains network. CCS TSI already provides mechanisms for RIMs to inhibit some functions (e.g. modification of adhesion factor by the driver) not relevant for their networks It is proposed not to inhibit any function above and beyond what is offered in the TSI, unless agreed and demonstrated practicable at NNI level.

Functions impacted	Proposed Approach on the NNI	Notes on deviation already implemented
Subset-40 and Subset-41	Use of TSI defined values or conditions. <u>Mandatory</u> for onboard subsystems. I.e. no further restrictions for Onboard subsystem beyond what is defined in TSI.	<u>For example</u>, TfNSW has restricted the permissible installation range for Euroantennas on its ETCS equipped trains to less than 6 m in lieu of 12m to avoid unnecessary modification of existing signalling assets (in ETCS Level 1 areas) to cover for the extended range specified in ETCS subset 40. The recommendation to comply to the TSIs is reasonably achievable under ETCS Level 2 and standard practice on new lines. It supports possibly cheaper installation on locomotives, where the use of single antenna for multiple cabs may be possible. Careful consideration and coordination with RIMs operating under ETCS level 1 will be required during a transition phase to be defined.
Other non-standard configuration.	Use of TSI defined values or conditions, unless agreed and demonstrated practicable for the NNI.	Detailed analysis with RIM, RSO and suppliers of the already mandated non compliances will be required to assess the possibility to not require them from 3 rd party trains or the merit to implement some of them consistently across the NNI.
Other non-standard configuration required to solve issues related to other TSI.	Common solutions to be agreed and mandated on all trains and mandated across the NNI.	As explained in section 5.3, not all issues identified will require customisation of ETCS products, as some of them could be managed by not implementing the functions. However, the current implementations have put in evidence that the solutions need to be agreed and coordinated amongst the implementers. As such it is proposed that the solutions agreed are mandated through the standards.

Table 6. Examples of current non-standard use of ETCS parameters already implemented in Australia



Question 6: Should non-standard use of ETCS parameters remain permitted for captive fleets so long as non-captive vehicles using the NNI and not implementing the onboard customisation can traverse the network without impact?

Are there some non-standard use of ETCS parameters already identified and implemented which would warrant a national application or could jeopardise Interoperability if not modified?

Further discussion related to this matter and the scope to which each of the future standards will apply to are addressed in section 5.6.

5.2.2 Customisation of functions

Depending on the applicability of the DTCT standards, it may be appropriate to allow RIMs/RSOs the discretion to decide that captive fleets operating on a contained area of the NNI (e.g. electric trains operating on an electrified passenger network) may deviate from the standard and ETCS TSI. However, the RIM would be required to design and assure that their trackside subsystems provide interoperability to compliant trains operating on their portion of the NNI.

In addition to deviations from the standard, some of the existing ETCS implementations in Australia have implemented additional functions above and beyond what is defined for the onboard subsystems in the ETCS Specifications. The impact of these customised functions on achieving interoperability greatly depend on the nature of the functions and their implementations by suppliers.

This includes, for example:

- Implementation of additional acknowledgement from the driver on the ETCS DMI, prior to releasing of the brakes once all ETCS conditions are meant.
- Additional release conditions trigger Service or Emergency braking by the onboard subsystem.
- Additional trackside failure reporting to the driver (mostly for ETCS L1 applications).
- Introduction of new functions requiring exchange of information between Infrastructure subsystem and Onboard subsystem: NSW Station Platform information to support Automatic Selective Door Opening, CRR function to manage stations equipped with Platform Screen Doors, CRR function to report smoke detected on the train. All these functions encapsulate the bespoke information exchanged between the subsystems using ETCS “packet 44” function.⁵

⁵ In ETCS language a dedicated function (ETCS “packet 44”) is available and configurable, for a trackside subsystem to transmit customised information to an onboard subsystem while preventing risk to interoperability for onboard subsystems which do not implement the bespoke function, as they will “only” disregard the information received. When using this function, a RIM should consider in its assurance that vehicles complying with DTCT standard operating on their areas of the NNI may not implement the customised functions, unless mandated by the DTCT standards.

It is presumed, albeit not formally confirmed, that each of these non-compliances or enhancements is supported by a rationale covering several aspects and in some cases safety. These justifications were made at the network level, but it is unknown if they would stand within the broader context.

These non-compliances are currently applied to vehicles which only operate within a single network (even if areas of this network are on the NNI). In a recent assessment of technical compatibilities between ETCS Level 2 rollout in Sydney and Brisbane (Ref 4) none of the current functional customisation introduce major incompatibilities - with one exception related to Train Numbering, described in section 5.3.2). However, the analysis demonstrated the need to strengthen the coordination between the initiatives to avoid increasing the risks to Interoperability.



Question 7: Should functional customisations remain permitted on the NNI, so long as non-captive vehicles using the NNI and not implementing the onboard customisation can traverse the network without impact?

Are there some functional customisations already identified and implemented which would warrant a national application or could jeopardise Interoperability if not modified?

Further discussion related to this matter and the scope to which each of the future standards will apply to are addressed in section 5.6.

5.2.3 Alternative onboard DMI

A fundamental point of alignment within the CCS TSI is the definition of the ETCS DMI. Every ETCS installation in the EU uses the standard DMI, and every supplier has a compliant DMI that (with a few minor exceptions) works in the same way as the ones from other suppliers.

EU experience evolved from a functional / performance-based definition of the display of ETCS DMI, to the current approach where the DMI is specified in a prescriptive manner to provide for a transparent experience for drivers irrespective of the onboard subsystem supplier. Indeed, the initial TSI (ETCS baseline 2) only included a functional interface specification (Subset-33 FIS MMI, 30 pages) which has been progressively replaced over the last 15 years by a detailed ETCS DMI specification (latest version 4.0.0 being 317 pages, see Ref 10). This change has been driven by the European RSOs.

The DMI is specified as an integral part of the ETCS onboard subsystem, and its specification only covers the elements interfacing with the driver (i.e. menus, graphical representations, naming conventions and colour schemes, etc.). The interface between the onboard vital computer and the display unit remains not specified by the TSI and is implemented using supplier specific solutions.

The DMI is defined in the CCS TSI as part of the Interoperability Constituent ETCS Onboard Unit along with most ETCS onboard functions (except the Odometry), and the compliance to the CCS TSI for suppliers' products is certified for the combined system ("Black Box" approach).

Today the use of external test laboratories in Europe, is greatly enabled by the standardisation on the ETCS onboard subsystem inclusive of the DMI. This has allowed the implementation of common test environments, automation of testing and the emergence of a competitive markets amongst the certified entities.

The knowledge of the ETCS onboard behaviour up to the information displayed to the drivers is a key factor allowing RIMs to assure that the configuration of their trackside and rulebook is fit for purpose. Any customisation would need to ensure that they do not negatively impact the ability to decouple the overall system and trackside assurance processes from the assurance of the onboard subsystem and its interoperability constituents, in order to avoid the need for bespoke complex integration and assurance for customised train classes on each network they may operate on.

Customised ETCS DMI on Australian projects to date

ETCS DMIs have been customised to different extents and adapted to local context on almost all ETCS projects in Australia so far. This was largely made possible due to the fact that the customisation happened on trains which operate on a single network, and/or with a limited number of suppliers involved both trackside and onboard, or a single entity was responsible of the overall integration and assurance (i.e. RIM/RSO and suppliers). DMI customisation may be a desirable path for an RSO for many reasons – for consistency with information displayed on other existing in cab systems, integrating the DMI with other vehicle management systems, to adapt to the limited real estate available on some driver's desk, to present additional information applicable to the particular operation, or for other reasons.

Aligned with the CCS TSI philosophy, a number of aspects not deemed relevant to achieve interoperability are excluded from the specifications and left to the responsibility of the RSO (e.g. overall integration within the vehicle and its systems, cab design and associated ergonomics, etc.). As such it is worth noting that some of these “customisations” are not actual deviation of the CCS TSI, which Ref 10 leaves possible as excluding them from the scope of the specifications:

- *3.2.1.4 Cab integration issues (e.g. which screen(s) is/are used for the interface between the driver and the ERTMS/ETCS onboard, the position of this/these screens inside the driver's cab, as well as which non ERTMS/ETCS applications are integrated onto the same screen(s) as the one(s) used by the ERTMS/ETCS onboard) are also outside of the scope of this specification.*
- *3.2.1.5 Even though this specification allows two possible technologies, namely touch screen or soft key, the specific hardware solutions (e.g. the number of screens, the size of hard keys,...) used to achieve the ERTMS/ETCS DMI are outside of the scope of this specification.*

Even if these changes are not technically a deviation from ETCS specifications, they certainly represent local developments which may prevent the use of off-the-shelf products offered and pre-integrated/assured by the suppliers.

Previous engagement with Australian freight RSOs operating at national level indicated the desire to investigate alternative display arrangement, different to the standard ETCS display – this was the genesis of the layout of the ATMS DMI. However, Ref 10 offers limited options on information to be displayed and interactions with drivers:

- *3.2.1.1 This document defines the interface between the driver and the ERTMS/ETCS onboard by detailing:*
 - a) information to be displayed to the driver in response to operational situations. This includes visual information for speed and distance monitoring, the symbols and [system] messages as well as audible information.*

b) the interactions between the driver and the ERTMS/ETCS onboard. This includes the dialogue sequences used during data entry.

Further, maintaining a single style of DMI could minimise the re-training effort as train drivers move from employment with one RSO to another, and would mean that the standard DMI would be available from a wider variety of suppliers.

NTC is planning to define a framework to support the rail sector in resolving this key aspect to national adoption of ETCS Onboard. This framework will be used during next stage to help converge on whether:

- The ETCS DMI should be mandated in Australia without modification beyond what is considered in the CCS TSI, or
- RSOs are provided flexibility to modify and develop a DMI to their requirements while complying possibly to some minimum functional requirements (to be identified), or
- Some agreed areas/elements of the ETCS DMI were to offer a common alternative option different from ETCS DMI Specification (e.g. ETCS “Planning Area”) through an Australia specification which would be read in conjunction with ETCS DMI Specifications, or
- A new Australian DMI specification was to be mandated as an alternative for ETCS DMI Specification (i.e. both would remain acceptable), or
- Other options.



Question 8: What successful frameworks, implemented globally or locally, can be used during the development of the standards to reach a conclusion which best balances:

- Australian RSO diverse needs, with
- Alignment with global supply chain and avoidance of captive markets, and
- Minimum requirements required by ETCS for RIM to assure through their trackside assurance the overall performance on their networks.

5.3 Impact of TSIs for other subsystems (i.e. not CCS)

5.3.1 Infrastructure, Rolling Stock and Energy TSIs

Some functions of the CCS TSI rely on concepts defined in other infrastructure TSIs. In some cases, the requirements specified in these other TSIs are directly embedded in the requirement for the CCS TSI. For example, a limited number of variables in ETCS language only offer the selection of values (or range thereof) which align with the definitions from other TSIs.

Dependencies from other TSIs on “structural” subsystems will require further analysis during the next stages of work. Not all of them are expected to prevent or impact on achieving interoperability objectives. As such these elements could be addressed in a lower Tier standard – for example those items contributing to a longer-term operational harmonisation may be assigned to a Tier 2 standard.

Critical dependencies from other TSIs which could prevent achieving Interoperability will need a common approach agreed and mandated across the NNI and the impacted fleet. This is particularly important for those dependencies which resolution could possibly impact ETCS products and their implementation across the NNI.

Table 7 provides an initial summary of some critical dependencies, along with initial notes on the potential impact and how the concepts might be managed in Australia.

Question 9: What critical dependencies from other disciplines might be missing, and what is your feedback on the proposed approach to manage them in the mandatory standards?

Subsystems	Concept	Description
RS, INF	“Loading Gauge”	Three categories of loading gauge (“GA”, “GB”, “GC”) are defined in the relevant TSI, while AS 7507 defines 37 reference vehicles. Standard should evaluate and mandate the best approach to follow on the NNI, which could include for example: ▪ Not to implement function (i.e. Route suitability”) trackside. ▪ Redefine the meaning of the 3 values allowed. ▪ Broader change in ETCS language which would lead to bespoke products, until requested to the ERA and officialised in future versions of the CCS TSI: – Change ETCS grammar to make use of the up to 8 values define for the variable (acknowledging that 5 of them are defined not to be used) – More important changes of language... ▪ Implement a local function to manage Australian gauges. Changes beyond the 1st two bullet points would require ETCS Onboard product changes which could indirectly require retrospective changes trackside beyond the extent of the NNI.
	Axle Load	Values do not fully align with the ones used Australia, but 12 values are available, and their meaning may be redefined to cover Australian needs. Options available may be similar to ones discussed for the “loading gauge”.
ENE, RS	Traction system	CCS TSI already proposes a mechanism to define Australian specific values but require its formalisation and officialising by ERA.

Subsystems	Concept	Description
INF, RS	Cant Deficiency Categories	Limits of ranges do not fully align with the ones used Australia, but 11 categories are available, and their meaning may be redefined to cover Australian needs. Note that these categories will have a direct impact on how “Static Speed Profile” (i.e. similar to speed signs) are communicated to, and supervised by the onboard subsystems. Options available may be like the ones discussed for the “loading gauge”. Misalignment and local application across the NNI is not an option and depending on the solution chosen, some ETCS Onboard product changes could indirectly require retrospective changes trackside beyond the extent of the NNI.
RS	Minimum braking performances as configured on the onboard subsystems	Minimum braking performance (as foreseeable to be configured within CCS onboard subsystem). As experienced by railway having implemented ETCS, the minimum braking performance to be used to design “interoperable” trackside will have to marginally evolve compared to the minimum brake performance typically used for signalling design (e.g. GW series of curves for Freight).
	ETCS Brake conversion model.	The ETCS brake conversion model has been specified and assured assuming that <i>“all the provisions laid down in the EN 16834:2019 (Railway applications - Braking - Brake performance), with the exception of sections 9.3.1, 9.4.1 and 9.5.2, apply for the acquired brake percentage.”</i> This standard is not in use in Australia and the differences needs to be identified along with their possible impact on the parameters of the model.
ENE, RS, INF, CCS	Electro Magnetic Compatibility	TSIs refer to EU harmonised standards for Electro Magnetic Compatibility (EMC), and in particular EN50121 for the CCS part. While modern railway commercial products tend to comply with EN standards or equivalent, this cannot be guaranteed it is the case across all fleets and all areas of the NNI.

Subsystems	Concept	Description
INF, RS	Eurobalises and Euroantennas installation rules	The minimum installation requirements for Eurobalises and Euroantennas have been specified to integrate with track arrangement complying with INF TSI and matching rollingstock arrangement complying with RS TSI (e.g. gauge and clearances, dual gauge tracks, etc.). The standard need to investigate the adequacy of such proposal in Australian context and additionally analyse if the increase of some of the tolerances could support an improvement in productivity (installation and maintenance).
INF	Fault tolerance to rail management practices	Onboard subsystem is specified to be tolerant to rail management practices in place in EU (e.g. storing of rail in the 4-foot). The development of the DTCT standards should identify early and confirm this is compatible with current practices in Australia on the NNI and possibly on other networks or part thereof where equipped vehicle could also operate even if not under ETCS supervision. Potential issues which can be solved with suppliers during the installation of trackside assets may be left outside of the standards. However, other issues which could only be solved by altering requirement for the onboard subsystems should probably be mandated in these standards.
INF, RS	Platform characteristics	ETCS includes function to send information to the Onboard system and then to the rollingstock about some characteristics of the Platform Train Interface, if required. In this function the range of values available to describe the platform height are aligned with the height considered in the TSI and do not align naturally align with what can be encountered in Australia and in particular on the NNI. Options available may be similar to the ones discussed for the “loading gauge”.

Table 7. Possible factors from other TSI that may impact on DTCT interoperability and performance

5.3.2 Operation and Traffic Management TSI

The Operation and Traffic Management TSI, sets the minimum requirements for RIM and RSO operations to ensure Interoperability objectives are achieved in the EU. It focuses on aspects where the overall performance of the railway requires a contribution from both RIM and RSO. This TSI does not only cover requirements for day of operations, but also during the (access) authorisation and operations planning phases.

TSI OPE not only addresses operation of ETCS system, but also the mission critical voice radio functions, which are currently not considered as part of the scope for DTCT.

A detailed analysis of the dependencies and the proposed resolution will have to be performed during the writing of the standards. Table 8 identifies a potential approach to each of the critical issues identified in the OPE TSI.

Phase	Who	Topics	Potential approach
Rollout, Authorisation	RIM	Identifying and publishing of ETCS/Radio System Compatibility.	See section 6
	RIM/ RSO	Vehicle Approval	See section 6
	RIM	Identification of Route Requirement related to CCS trackside implementation (e.g. min version, need for train integrity monitoring on the train, etc.)	See section 6
Operation Planning	RSO	Route Compatibility check prior to staff and vehicle allocation.	See section 6
Day of Operation	RIM/ RSO	Any aspect relevant to nominal operation involving elements of CCS and considered in the TSI (included its safety justifications).	To be included in the standards for adoption. Local adaptation / improvement / contextualisation (e.g. templates to be used, etc.) to be included in standards if critical to achieve Interoperability, or lower Tier standards if to enable overall operational harmonisation.

Phase	Who	Topics	Potential approach
	RIM / RSO	Any aspect relevant to operation not directly involving elements of CCS but assuming their behaviour and considered in the TSI. This could include for example, emergency situations, worksite protections, etc.	Subject to result of analysis: ▪ Tier 1 standards if critical for Interoperability on the NNI, or ▪ Lower Tier standards if not critical to achieve Interoperability on the NNI, with Tier 2 if supporting overall operational harmonisation.
	RIM / RSO	Any aspect relevant to operation with failed assets involving elements of CCS and considered in the TSI (included its safety justifications).	To be included in the standards for adoption. Local adaptation / improvement / contextualisation (e.g. templates to be used, etc.) to be included in standards if critical to achieve Interoperability, or lower Tier standards if to enable overall operational harmonisation.
	RIM / RSO	Any aspect relevant to operation with failed assets involving elements interfaced with CCS and considered in the TSI (included its safety justifications)	To be included in the standards for adoption. Local adaptation / improvement / contextualisation (e.g. templates to be used, etc.) to be included in standards if critical to achieve Interoperability, or lower Tier standards if to enable overall operational harmonisation.
	RIM / RSO	Any aspect relevant to operation with failed assets involving elements interfaced with CCS and not considered in the TSI.	Subject to result of analysis: ▪ Tier 1 standards if critical for Interoperability on the NNI, or ▪ Lower Tier standards if not critical to achieve Interoperability on the NNI, with Tier 2 if supporting overall operational harmonisation.

Table 8. Approach considered for categories of elements of the TSI OPE having a potential impact on CCS.



Question 10: What are other dependencies that need to be identified, and what is your feedback on the proposed approach for their inclusion in the mandatory standards?

Australian format for Train Numbering

The Train Numbering approach currently in place across the NNI uses a format which can support up to 5 Alpha numerical characters making up the number for each train. In contrast, the TSI OPE defines a Train Running Number (TRN) which is expressed in a format of up to 8 numerical digits. In ETCS applications this information recorded in the variable named “NID_Operational,” which contains the value of the TRN coded over 32 bits.

ETCS do not need this information to work as intended, but it can be used to interface with non ETCS systems (e.g. Network Control / Traffic Management Systems), and other elements of the CCS. The TRN is critical for the functioning of the Radio subsystem for Voice Critical Applications, and for ATO.

Different attempts have been made in Sydney and Brisbane to translate between number formats, while minimising technical impact on their CCS products, i.e. keeping the native format for back-office equipment while using the Australian format for interaction with drivers. Both projects have adopted similar but different options which could if uncoordinated across the NNI lead to incompatibilities and prevent Interoperability. This is a clear example of the need for coordinating the implementation deviations from the TSIs.

At this stage it does not appear practicable, credible or even within the scope of the standards to mandate the transition to the use within Australian railways of the 8 numerical digits format. It is proposed for the standard to mandate a technical approach which can be used consistently across the NNI, while ensuring transparency to operating staff and protecting investments already in service.

5.4 Railway Mobile Radio (RMR)

5.4.1 Australian Radio Context for ETCS

As noted in section 2.4, ETCS relies inherently on the capability to transmit critical data between trackside and onboard subsystems. Part of this transmission is achieved through the use of transponders on the track (“balises”) and antennas mounted underframe. In addition to this, ETCS deployments using Level 2 require the use of a compatible data radio.

Currently both ETCS Level 2 rollouts in Sydney and Brisbane are using a packet switched version of GSM-R as their radio technology (trackside and matching onboard). GSM-R is specified as part of the CCS TSI and naturally supports integration with ETCS. GSM-R is based on “2G / 2.5G” mobile radio technology, which is becoming obsolete. The European rail sector and telecommunications industry are working on the development of the next generation of radio technology to support the needs of railways. Unlike the approach taken with GSM-R, where the technology used by public Mobile Network Operators (MNO) was customised to achieve the

objectives set by the European rail sector, the new approach will take the railway specific needs away from the telecommunications core products into applications based subsystems, or when not possible has contributed to the development of the new generation (“5G Mission Critical Services” and onward) telecommunications technology to ensure needs of railways are considered upfront and are provided through a radio-agnostic interface to different radio technologies. This will support the broader use of non-railway specific products.

The latest version of the CCS TSI now offers an initial baseline set of specifications for this new subsystem called Future Railways Mobile Communications Systems (FRMCS). At the present the baseline available in the CCS TSI only supports the rollout of the technology on pilot lines in Europe. The next FRMCS baseline within the TSI will be released around 2027/2028 to support wider deployment for all railways.

RMR (i.e. GSM-R or FRMCS) as specified in the CCS TSI, covers more than the data transmission capability to support ETCS. Indeed, the main function of RMR remains its mission critical voice capabilities. FRMCS specifications are also considering augmented capabilities to cover other non-mission or safety critical applications.

Of particular relevance to this paper, FRMCS Onboard subsystems are now specified to act as a gateway which will have the capability to coordinate the connection through multiple radio technologies, in addition to the capability to connect to FRMCS radio Infrastructures. This gateway/routing capability is reflected in the proposed DTCT onboard radio architecture illustrated in Figure 9. It is key to allowing a train to use the relevant radio network for the railway it is operating on.

Sydney Trains and Queensland Rail are planning to transition their GSM-R infrastructures to FRMCS infrastructures (i.e. a private 5G network) in the future.

The Melbourne suburban network has also implemented GSM-R but at this stage it is used only for mission-critical voice functions. Other ETCS Level 2 implementations outside of the NNI have opted for other radio technologies.

The railway network in Perth is currently deploying a new radio system which will support mission-critical voice functions, and the data transmission for its High Capacity Signalling project implementing proprietary DTCT technology (i.e. CBTC). The radio system proposed seeks to align with elements of FRMCS. However, it relies on advanced 4G radio technology, while aligning to the n3 band for railways (see below) and complying to (3rd Generation Partnership Project) 3GPP specifications release 14. ETCS data transmission remains possible over such technology so long as compatible radio equipment is available on trains.

5.4.2 Management of radio frequencies for railways

There is no mandate currently in Australian for railways to use one specific radio technology or another. However, the use of radio technologies by the railways and their associated requirement on the spectrums (if required) is subject to licencing arrangement managed by the Australian Communications and Media Authority (ACMA).

Currently, the 1800 MHz spectrum (i.e. n3 band) has been allocated in major Australian metropolitan areas to railway operators for critical communication systems until at least 2028, to support the deployment and operation of GSM-R in Melbourne, Sydney and Brisbane, as well as the deployment of 4G radio system in Perth.

The FRMCS standard defines two possible spectrum bands to deploy FRMCS systems: 5G band n100 and band n101. The Australian Railway Association (ARA) is coordinating the requests of the railways with ACMA and, at this stage, only 5G band n101 will be made available to Australian railways for FRMCS.

Negotiations are still happening between the railways and ACMA with respect to the future use of the n3 band by railways during the transition to n101 band and beyond.

Area	Band	Spectrum
Australia	n3	Uplink 1770 – 1785 MHz Downlink 1865 – 1880 MHz
Australia and Europe	n101	1900 – 1910 MHz

Table 9. Australian spectrum frequency allocated to railways

The international rail communications industry is currently developing and testing products which will work in the n100 and n101 bands initially, in alignment with European migration roadmaps to FRMCS. It may be possible in the future to procure FRMCS equipment that operates in band n3, should it remain available to Australian railway operators after the decommissioning of GSM-R networks. However, the FRMCS supplier ecosystem that is ready to support band n3 may be limited, with potential commercial implications.

The use of the spectrum allocated to the Australian railways is not mandatory and railways can decide to use radio technologies or subcontract services already authorised to operate within other bands. Current examples include ARTC subcontracting to Telstra (see NTCS below) or Aurizon implementing a Tetra radio system on the Central Queensland Coal Network.

5.4.3 National Train Communication System (NTCS)

The Australian Rail Track Corporation (ARTC) decided more than a decade ago that investment in implementing a private radio system across its network is not economically viable, given the wide geographical extent of the network.

ARTC established an agreement with Telstra to deliver the National Train Communications System project (NTCS), providing radio services along the ARTC corridor re-using Telstra's pre-existing infrastructure and augmenting it in some dedicated areas. The service was planned to support the previous DTC Technology considered by ARTC (i.e. ATMS). NTCS currently provides coverage where the Telstra 4G network has coverage, thus extending well beyond the ARTC corridor and overlapping for example on significant portions of the Sydney Trains and Queensland Rail corridors.

Despite the advance in FRMCS specifications and the upcoming availability of commercial products, it is unlikely that this will change ARTC strategy from relying on the use of a public Mobile Network (NTCS) – the economics of a private network will likely remain as unfavourable as previously assessed.

The current radio implementations discussed above are summarised in Figure 8.

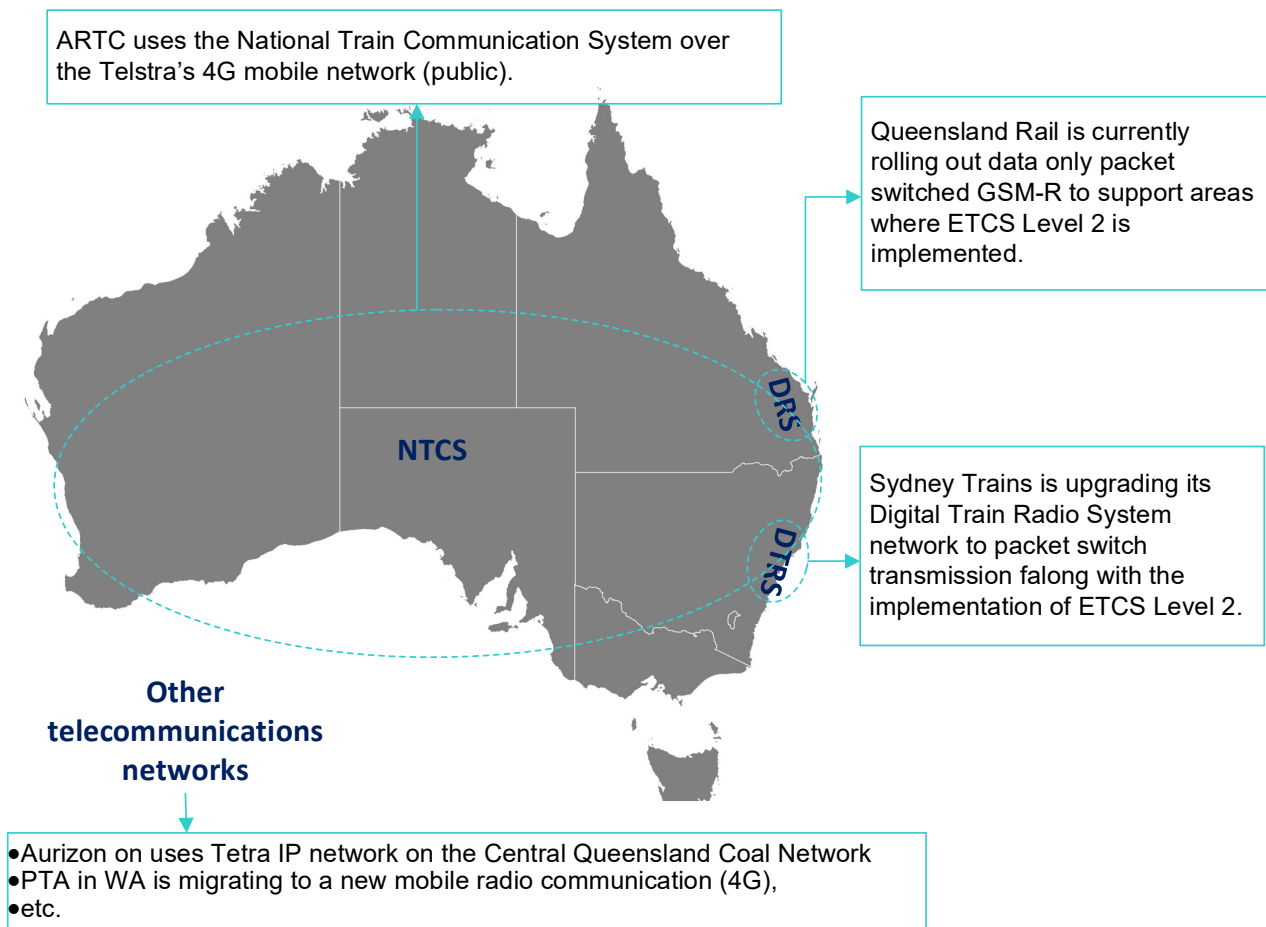


Figure 8. Radio networks available for DTCT in Australia

5.4.4 Overview of future Radio Architecture

The challenge faced by the future Australian standards will be to

- Balance the flexibility for RIMs to choose the technology best adapted for their networks.
- Controlling the number of matching assets required to be fitted on the vehicles.
- Ensure stability of the onboard fitments (and associated investments).
- Minimise the need to locally customise DTCT products to integrate with the chosen technologies.

At the present the foreseeable radio technologies for DTCT include:

- existing Global System for Mobile Communications – Railway (GSM-R) until replaced with Future Railway Mobile Communication System (FRMCS), using the radio spectrum assigned to railways in Australia,
- public mobile networks providing service to Australian Rail Track Corporation (ARTC) as part of the National Train Communication System (NTCS).

Previous studies and strategic analysis have also highlighted the merit of using satellite communications in remote areas of some Australian railways (subject to suitable coverage and features for Australian DTCT). Although satellite communications are currently in use for

proprietary DTCT applications, and although the use of satellite networks as a Transport Stratum is contemplated in FRMCS specifications, there is no immediate roadmap within industry suppliers to provide satellite-based solutions in the near future. This means that satellite-based DTCT, although technically possible, may not be commercially available for some time.

The proposed approach is to mandate the use of FRMCS architecture on the train, in particular its gateway functions, and augment it at least with the capability to manage connection with NTCS, and possibly consider additional space proofing and extension capability to either:

- Manage the short-term need for some trains to connect to GSM-R networks (See section 5.4.5).
- Prepare for introduction of future capability (e.g. satellite communications, 4G/LTE).
- Prepare for future migration requirements.

The form and fit of the radio equipment remain supplier specific so defining the space proofing requirements will be consulted at a later stage with the stakeholders. However, this could range from 2 additional slots in the already planned DTCT radio equipment to a space for a typical 19-inch rack (approx. 50cm wide x 20 cm high x 50 cm deep).

Such approach would minimise the customisation of the ETCS onboard components as it would implement the standard interface to FRMCS gateway, which would in turn manage the routing from one communications / radio technology to another.

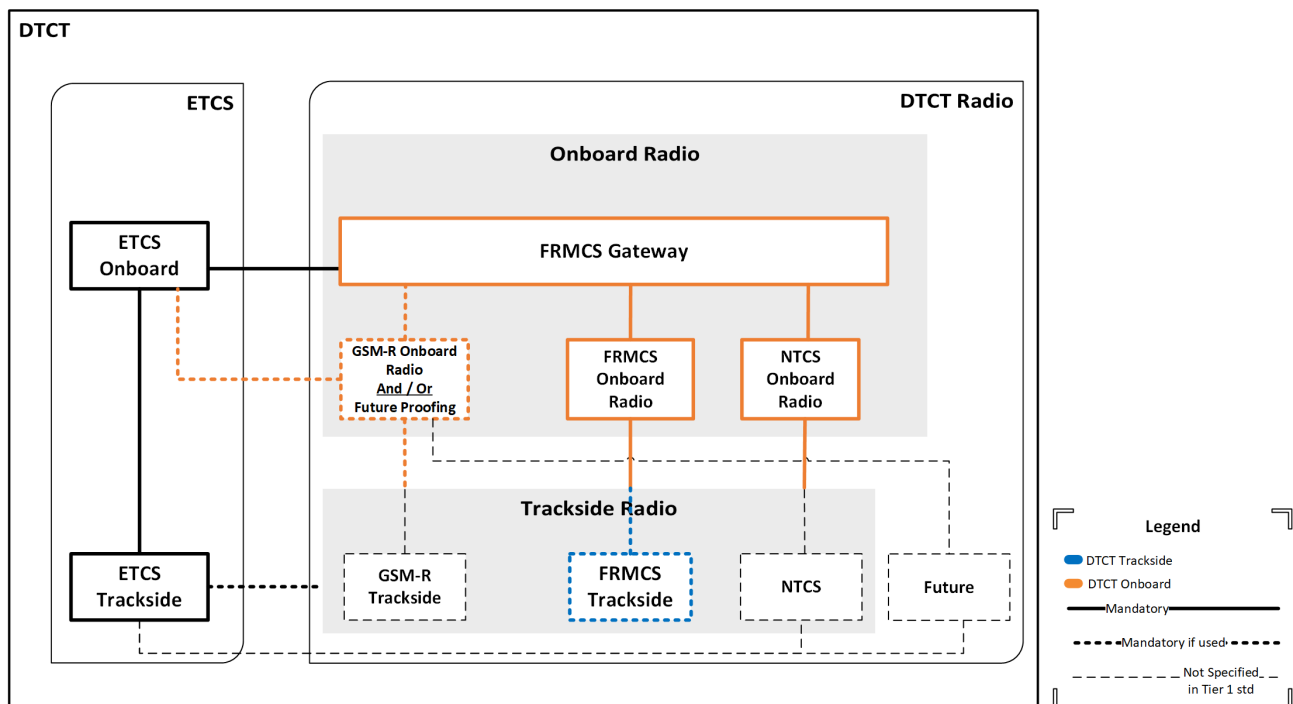


Figure 9. Proposed DTCT radio architecture

Note - for RIMs wishing to implement FRMCS or GSM-R infrastructure on their networks for non-DTCT reasons (for example to enable voice application), it may also become mandatory to comply with parts of the TSI relevant to the data transmission for ETCS, on the areas which form part of the NNI.

While mission critical voice functions are not part of DTCT standards, such approach could support the migration of the GSM-R voice capability of the In-Cab Communications Equipment (ICE) to FRMCS in Sydney at least, without the need to introduce new assets on the non-captive trains.



Question 11: Do you agree on the proposed approach for managing radio capability on the trains?

5.4.5 Migration to Future Railway Mobile Communication System (FRMCS)

In Australia, the migration from GSM-R toward FRMCS is a challenge which will be faced by Brisbane, Melbourne and Sydney, especially for their captive fleets already equipped with GSM-R for data and / or voice. This migration is more complex for mission-critical voice services than it is for data services, such as those supporting ETCS.

The starting situation on the NNI is however very different today in Australia compared to Europe:

- GSM-R mission-critical voice functions are only used in Sydney and Melbourne, and non-captive fleets operating on these networks manage such capability with custom build In-Cab Equipment (ICE). Mission-critical voice functions do not form part of these DTCT standards.
- The future NSW Regional Rail project is delivering the only funded non-captive fleet (i.e. 29 trains) to operate under ETCS L2 supervision over GSM-R (GPRS).
- Future non-captive trains planned to operate under ETCS Level 2 over multiple networks on the NNI will require radio technologies commensurate to the context of the NNI at the time they start operation. This means that some if not most of them may not be impacted by the GSM-R migration because it would have already been completed for the data services on these areas, or at least their potential exposure to GSM-R may be very limited in time.

The TSI CCS Annex A addresses ETCS Readiness for FRMCS 5G based communication. For fleets already equipped with GSM-R, FRMCS will need to work in coexistence with GSM-R at least until the mid-2030s. To support this, several intermediate architectures (See Ref 11) are being considered in Europe to support migration for trains already equipped GSM-R data radios onboard. One of the possible architectures to support migration of data services is illustrated in Figure 10. The pros and cons of each architecture are described in Ref 11 and consider the:

- need or not to upgrade existing ETCS Onboard,
- need or not to modify GSM-R onboard,
- modify long term FRMCS onboard architecture,
- products availability.

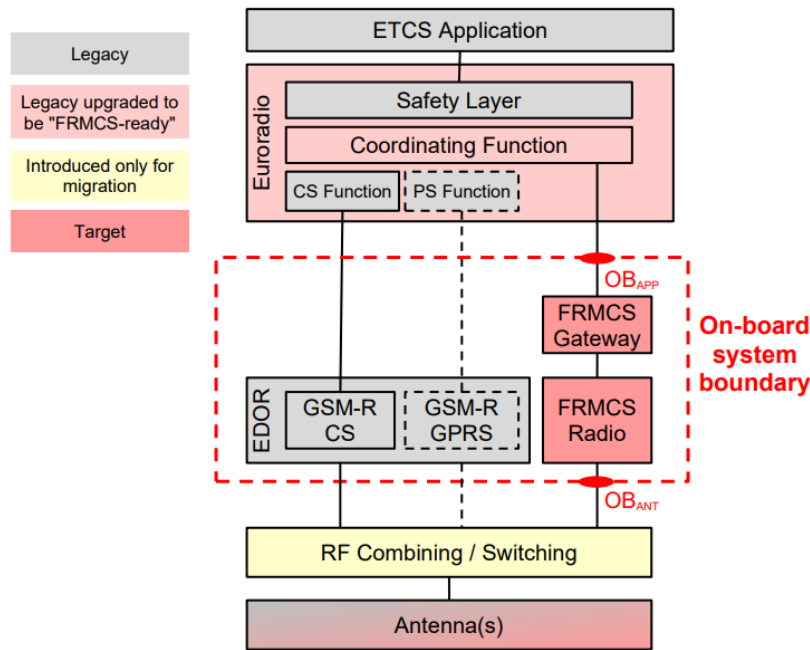


Figure 10. Possible Onboard logical architecture supporting migration from GSM-R to FRMCS

This option, or other alternative architectures, are available for the Regional Rail fleet and will be subject to decisions mostly from Sydney Trains and Queensland Rail, but could also involve Victorian organisations, depending on the timeframe and geographical considerations of their ETCS rollout.

As described elsewhere, it may be appropriate that the DTCT standards may apply to captive fleets operating in Sydney and Brisbane, so the architecture chosen for them may be decided by their respective RIM/RSO.

Given the current stages of planning for the migration toward FRMCS and ETCS level 2 in Sydney, Brisbane (and Melbourne), it may not be appropriate for the standards to mandate the installation of GSM-R onboard capability on vehicles covered by the DTCT Onboard standard but not yet equipped with GSM-R (for example, privately operated locomotives). Alternative approaches that may be used in Sydney and Brisbane may be

- coordinate the rollout of ETCS and FRMCS trackside on the areas of their network being on the NNI, or
- make use of the NTCS coverage on their networks as the data service for the non-captive fleets.

Further engagement on this issue is required during the development of the standards



Question 12: Do you agree with the proposed approach for managing the migration of GSM-R to FRMCS while rolling out ETCS on the NNI areas currently covered by GSM-R?

5.4.6 Roaming Interconnections

Trains may freely use and roam between GSM-R or 5G/FRMCS private radio networks owned by two different RIMs, subject to the establishment of a roaming agreement between those networks.

A roaming agreement, as defined in existing 3GPP standards, will be required to allow visiting radio units (DTCT Onboards) to connect to trackside private radio networks (DTCT Trackside) without requiring the provision of a dedicated SIM card for that network, as happens in 3G/4G/5G public Mobile Network Operators across the world.

When a DTCT Onboard requests attachment to a new network different from its home Network (the network that has issued its valid SIM or eSIM card), the Visited Network will authenticate the identity of the visiting device by validating its identity with the Home Network, as well as confirming the services the visiting device may have access to.

To complete this authentication process, a roaming exchange interface must be implemented between the Home Network and the Visiting Network. The roaming exchange interface is defined in 3GPP technical specifications.

Currently, there are no roaming agreements between the current railway private radio networks in Australia and roaming interfaces have not yet been implemented between Sydney and Melbourne GSM-R (for voice) or between Sydney and Brisbane (for ETCS data). Presently, radio units are administratively registered on multiple networks but this will not be a viable long-term solution with the increasing number of DTCT equipped networks and trains. It will be appropriate for the standards to set out the required technical solutions to interconnect the private railway networks.

Note that in addition to the technical interfaces, agreements and operating procedures will need to be put in place between RIMs despite not currently having a railway interface (e.g. between Sydney Trains and Queensland Rail). These operating procedures are not covered by the TSI OPE.

There has been historically a lack of appetite to establish roaming agreements between Mobile Network Operators (MNOs) and railway operators for their private networks, due to commercial reasons and the technical complexity entailed in a non-standard (non-MNO) roaming agreement. Therefore, the standard may need to consider separate radio module arrangements for GSM-R/FRMCS and NTCS networks, whereby trains are registered independently on the NTCS network (i.e. a separate SIM card) to manage data transmission over NTCS. This same arrangement may also apply to other future networks for which roaming agreement is difficult to achieve.



Question 13: Do you agree on the proposed approach for managing the interconnection of railways private radio networks and their separation from the NTCS?

5.5 Alignment of principles

Early implementations in Europe concentrated on technical compatibility and compliance with the TSIs only. However, this led to what has colloquially become known as ‘dialects’ of ETCS in different countries’ implementation.

A key lesson learned is that to truly achieve interoperability and a consistent operational outcome, it is necessary to align at a lower level – alignment on key signalling and application principles that are well beyond the limited parameters specified in the CCS TSIs.

The intention that has been adopted in any later deployment is to ensure that, regardless of the network and trackside supplier, the driver experience is the same in a comparable circumstance, or, where this is not possible, that no confusing differences are created.

This mirrors the approach that has been adopted in Sydney to achieve alignment between the ETCS systems provided by different suppliers.

As already identified in section 5.3.2 ETCS does not mandate operating requirements. Minimum requirements are covered in a separate Technical Specification for Interoperability relating to the operation and traffic management (TSI OPE).

The selection of different operational rules in ETCS are reflected in the choice of various ETCS parameters (levels, modes and functions), as permitted by the technology.

While operational differences between ETCS networks don't cause incompatibilities, they can result in different processes across networks. Drivers would need to learn and apply these processes while staying proficient in performing additional tasks or using rarely used ETCS functions. This situation could increase the risk of errors or inefficiencies, for example in times of degraded working.

5.5.1 Current discrepancies between ETCS Level 2 implementation along the eastern seaboard

Table 10 outlines topics that have been previously identified (see Ref 4) in current ETCS Level 2 applications in Australia and need to be considered for alignment of operating rules. The table does not intend to be exhaustive and does cover differences which may exist with ETCS Level 1 operated areas, subject to how long shall they remain on the NNI.

ETCS Item	Subject	Possible consequence if not harmonised
Different ETCS “National” Values	Networks have reflected their different operating rules into different values for ETCS “National” Values. ETCS NV are the specified mechanism to reflect the local rules to be enforced by ETCS. This can include the maximum speed a train can operate in degraded situation (e.g. passing an authority limit at stop, travelling through a failed axle counter, etc.	
Virtual Balise Covers (VBC) activation by drivers	Some applications require a manual driver input to activate the VBC while others only rely on the reading of balises by the train automatically.	
Different sequences of events and driver involvement before 1st Movement Authority	Drivers may need to apply processes with some differences to reflect the different technical solution adopted by the networks. They will need to remain competent to perform the additional task, such as confirming ETCS Request on their DMI on some networks but not others.	These examples could lead to increase the potential for errors or inefficiencies.
Trackside « plain text messages »	Different ETCS “plain text messages” (sent from trackside and displayed on the ETCS DMI) requiring same actions or same “plain text messages” requiring different actions could increase the potential for errors or inefficiencies.	Need to investigate the possibility to harmonise the operational cases with a particular focus on the options which lead to different operational outcome noticeable by the drivers.
Driver action on DMI	Some functions in some mode rely on the driver manually selecting the function on the DMI. Variations in these selection processes across networks can lead to confusion and misinterpretation by drivers, especially if they are not familiar with the specific rules and practices of a particular network. For example: - For Staff Responsible mode the speed limit can be entered by the driver. The speed limit given by the driver prevails over the National/Default value. - Selection of shunting mode by a driver	

ETCS Item	Subject	Possible consequence if not harmonised
Trackside signage	TSI do not prescribe the trackside signage to be used on lines equipped with ETCS, or the form they have to take (apart from the ETCS “Marker Boards”). This can include for example permanent or temporary speed signs, various limits: yards, shunt, etc.)	
Default Values configured onboard	The value of an ETCS mode related speed restriction is determined by the corresponding national value (received from a trackside on one network) or the corresponding default values if the national values are not applicable or lost. Default values are pre-set values configured onboard that remain constant and do not change. A Train could lose National Values and revert to default values which may not be adapted to operational needs: for example, for the speed on ETCS unfitted areas, V_NVUNFIT due to the reading of any BG with a new NID_C (compared to its NV stored onboard) before a L2 area.	Indirect impact of ETCS onto networks not equipped with ETCS should be analysed and agreed. Need to manage and coordinate the configuration of ETCS deployments across Australia to avoid introducing negative side effects that ETCS equipped trains may suffer outside of ETCS equipped networks. This topic is also discussed in section 5.2.1.
Supported ETCS functions activated in some networks only	Several ETCS functions (e.g. packets 45, 63) and configuration could exist on one network but may not have been used on another. This could also apply to special local functions transmitted using ETCS packet 44.	While there may not be any technical compatibility issue with such ETCS functions, there may be a need for further analysis and additional integration activities to make sure trains are ready for operation.

Table 10. Current examples of the impact of different operating rules in Australia

5.5.2 Alignment of engineering principles

A potential way forward for alignment of principles would be to identify a common set of operating principles applicable across the NNI. This could typically include:

- Usage of some ETCS driving modes or preclusion of others.
- Common start-up scenarios.
- Common degraded scenarios.
- Scenario for entering and exiting networks, including level transitions and managing telecommunications matters at borders.

Then a small number of generic configurations could be identified with their associated ETCS solutions. Such configurations could include different approaches between urban and non-urban contexts:

- Urban – potentially based on an alignment of the solutions adopted in Sydney and Brisbane. This could typically include:
 - Common scenarios related to operation in double-track, bidirectional tracks.
 - Common degraded scenarios in dense areas.
 - Common scenarios operating ETCS trains across and around worksites.
 - Etc.
- Non-urban – which could typically include:
 - Common scenarios related to operation in double-track.
 - Common scenarios related to operation in single track and loops.
 - Operating in areas with limited radio coverages.
 - Operating in areas with manually operated devices.
 - Common degraded scenarios related to the above.
 - Etc.

Although no requirements have been identified yet, future requirements could include for example:

- Operating in areas without train detection or implementing virtual blocks.
- Operating in areas relying on satellite communications for DTCT data.

The DTCT application in each configuration would need to be defined to a reasonable degree of specificity to ensure a consistent operational experience across different applications. This would have the impact of constraining the freedom of each individual RIM but might also reduce cost and time for implementation with standardised solutions.

This approach is also likely to mean changes in operational practices and potentially infrastructure changes for the early implementers, to ensure complete alignment if desired in the long term.

This level of specification may be better included as a non-mandatory requirement, with networks on the NNI expected to align with the harmonised principles unless there is a compelling reason not to.



Question 14: Do you think it is viable to align DTCT principles to achieve alignment of operational rules:

- Is it practical to align engineering principles across jurisdictions?
- Does the framework outlined above seem reasonable, or are there more appropriate frameworks?
- Should DTCT signalling principles alignment be mandatory, or recommended?

5.6 Standards applicability

The decision to implement DTCT on a network or given vehicles will not be part of the proposed standards. This decision will remain under the responsibility of the RIM and RSO but may be influenced by policy decisions for the NNI and the fleets operating on it. Discussions below on the applicability of these standards, may inform the development of the standards but also inform policy decisions.

It is proposed at this stage that both DTCT Trackside standard apply to all DTCT supporting services on the NNI, and DTCT Onboard standard to all vehicles operating on areas of the NNI.

The impact of the requirements mandated in the standards could, if not carefully considered, extend beyond the limits of the NNI, as many trains and vehicles operating on the NNI also travel onto other networks or corridors. For example,:

- Excluding an option on all trains operating on the NNI may indirectly prevent a RIM from using these functions on networks or areas outside of the NNI, however
- Mandating functions to all trains operating on the NNI to achieve Interoperability (on the NNI) may impose additional fitment of equipment on vehicles that only very infrequently travel on the NNI.

Some alternatives could consider that the applicability of the DTCT Onboard standard is restrained to all vehicles which nominally operate over parts of the NNI managed by more than one RIM.

This would typically include standard gauge locomotives and the TfNSW New Regional Fleet, but would exclude passenger electric trains only used on their respective networks (e.g. Sydney Trains, Queensland Rail, etc.).



Question 15: Do you support the proposed approach to apply DTCT Onboard standard to all vehicles which nominally operate over any part of the NNI? If not, what is the reason for such answer?

As explained in Section 5.2) and above, mandating or excluding customisations of ETCS will need to be considered not only in relation to the impact on the Interoperability on the NNI but also the consequences this may have on networks that have already implemented such deviations on their infrastructure. Indeed some RIMs / RSOs with a certain level of “vertical” integration may find value in implementing “customised” functions which provide direct benefits to their operations. These past decisions may remain acceptable as long as they do not prevent the interoperability (of trains not implementing the “customisations”) on the areas of their network forming part of the NNI.

In developing the standards, it will be necessary to acknowledge the needs of these organisations and carefully consider the area of application of the standards to achieve Interoperability across the NNI, while not unduly restricting the ability for RIMs to make decisions on their networks as reflected in our co-regulation model.

Achieving the right balance on the applicability of both DTCT Standards will become critical when DTCT onboard implementation becomes more widespread, as this could de facto require existing no-longer-compliant DTCT trackside not on the NNI to be upgraded to comply with the new standards.

It is proposed that the applicability of the DTCT Trackside standard is restrained to only the tracks (vs networks) included in the definition of the NNI as well as portions of adjoining tracks required to achieve interoperability entering and leaving the NNI.

This would typically exclude tracks mostly used for localised operations within a given network (e.g. areas of the Sydney Trains networks used exclusively for suburban passenger services, narrow gauge areas of the Queensland Rail network, etc.).

Note: it would remain possible for RIMs and RSOs, and in particular for new adopters, to select to apply the standard beyond the areas for which they are proposed to be mandated, as this could support greater consistency on their networks, and the use of solutions readily available by multiple suppliers in the longer-term.



Question 16: Do you support the approach to restrict the applicability of the DTCT trackside standard only to tracks part of the NNI and those supporting entry and exit from the NNI? If not, what is the reason for such answer?

6 Managing Interoperability during Delivery

Australia has the opportunity to leverage the European certification process within the TSI, the Interoperability Directive and other legislative elements, by adapting these processes to align with its own regulatory environment and governance bodies.

This adaptation should ensure that the adapted standards embed the lessons learnt overseas and maximise the opportunity for cross acceptance with what is already certified.

6.1 European Certification, Approval and Authorisation framework

Europe's framework for interoperability goes beyond detailed technical (& operational) specifications. It defines a comprehensive process and ecosystems of actors contributing to the overall assurance of the products and subsystems. This leads to eventually authorise infrastructures and vehicle to enter service while minimising the needs for local specific authorisations.

As already discussed in Section 3, the European framework today is the results of 20+ years of evolution. Initially, compliance to the TSI was certified at national level, with the ERA's role being to encourage interoperability. The current approach still relies on certification of products and subsystems by independent bodies. However, the ERA now plays a central role for vehicle authorisations. National Safety Authorities (NSA) remain accountable for authorising infrastructure to be brought into service, but the ERA issues an approval to guarantee compliance with the TSI.

The objective of the EU framework is that:

- Interoperability Constituents (ICs) can be developed and certified by the industry ahead of projects and independently of the end-users.
- Vehicles are approved once and for all compliant trackside subsystems.
(Note that the TSI retain the provision for RIMs to perform some additional "confidence checks", particularly for older ERTMS versions. These are named ETCS System Compatibility (ESC) and Radio System Compatibility (RSC) checks.)⁶
- Trackside is authorised to enter service, in such a way that it allows vehicle types having demonstrated compliance to the TSI, any relevant "National Rules" for the network, and safety requirements, to operate on the network without needing further tests or local approval aside from routine operational approval such as "Route Compatibility Checks".

⁶ ESC/RSC are temporary confidence checks that RIMs may use to validate that vehicles will adequately interface with known interpretational 'grey areas'. RIMs can decide that these checks be performed through desktop analysis, laboratory testing, or onsite testing, with strong drive to avoid the onsite testing and repetition of checks already covered and assessed independently. See 7.2.3, Step 3, below.

As outlined in section 3, the requirements of the EU framework are described over multiple legal documents in Europe. Simply complying with (and transposing) the TSIs in Australia would not be enough to replicate such approach.

Should interoperability issues be detected, the European framework presumes that the onboard subsystem complies to the CCS TSI, if it has successfully gone through the certification process. To counterbalance this bias, the certification and approval of vehicles involves a higher number of independent entities as well as a greater level of prescription within the specifications.

Figure 11 provides a high-level overview of the European certification process, with a focus on the CCS TSI. This framework is used as the basis of what is proposed for DTCT in Australia. Figure 12 in section 6.2 illustrates the possible framework for use in Australia following a similar template to facilitate comparison between the 2.

The EU framework includes the following steps:

5. Interoperability Constituents Conformity Assessment⁷: This step covers design and production phases of an Interoperability Constituent (IC) and ensures that the IC (products or group of products) comply with the relevant TSI requirements. It involves a Notified Body (NoBo) who independently assesses and confirms that the design and manufacturing meet the specified standards. The NoBo then issues an EC certificate and the IC may be placed on the market across the EU. In parallel, National verification of components not underlying TSI rules (systems, cables, etc) and safety assessment of these parts are performed.
6. Subsystem Verification (i.e. as configured for a project): The assessment bodies NoBo, Designated Bodies (DeBo, who check compliance with national rules) and CSM Assessment Bodies (AsBo, if applicable, who evaluate the safety requirements) assess the CCS subsystem, including the integration of the ICs within the subsystem and the integration with the vehicle subsystems and the trackside CCS subsystem. Note that Safety Assessment by an AsBo can also be conducted to ensure that the ETCS sub-system is safe for operation. This includes evaluating the risk management processes and safety measures implemented.
7. ETCS System Compatibility (ESC) / Radio System Compatibility (RSC) are checked. The ESC and RSC provide evidence for technical compatibility between Onboard and a certain trackside for which its RIM has identified the need for additional checks beyond standard. NoBos are responsible for verifying the correctness and completeness of the check reports for the subsystem.
8. Each RIM apply for a Trackside Approval (TA)⁸ and RSOs apply for Vehicles Authorisation(VA)⁹ to the ERA.
9. Once conformity and safety are verified, RIMs must obtain Authorisation to Place into Service (APS) from their respective National Safety Authority (NSA). Note that NSAs can issue their authorisation ahead of ERA Trackside Approval.

⁷ Guide for the application of TSIs-Conformity assessment and EC verification
(https://www.era.europa.eu/system/files/2022-10/Guide%20for%20Conformity%20assessment%20and%20EC%20verification%20%28EN%29_0.pdf?t=1741805633)

⁸ Applications for ERTMS Trackside Approval (TAs) | European Union Agency for Railways
(https://www.era.europa.eu/domains/applicants/applications-ertms-trackside-approval_en)

⁹ Applications for Vehicle (type) Authorisations (VAs) | European Union Agency for Railways
(https://www.era.europa.eu/domains/applicants/applications-vehicle-type-authorisations_en)



The TA from ERA, does not only review evidence of compliances submitted by applicants, but it also seeks to identified previously observed configurations having led to Interoperability issues.

The RSO's application for vehicle and/or vehicle type authorisations undergoes a thorough review, including safety assessments and verification of compliance with interoperability requirements.

10. The Authorisation to Place on Market (APoM) confirms that the Vehicle is compliant with national and European regulations (Including CCS TSI) and is safe for operation.
11. Network access criteria are used by the RSO in compliance with the TSI OPE to check the compatibility of the vehicles composing a train, with a route to be operated on (Track characteristics, track gauge, electrification, axle load, ETCS level, need for Train Integrity Monitoring System, etc).

Fundamental to the approach is the cross-acceptance from the lower levels upwards and between entities. This is not achieved by coincidence or good will and is enabled by a defined and commonly accepted framework which characteristics are further discussed in section 6.2.1.

It is fair to observe that, in the Australian rail sector, lack of industry-wide cross acceptance is a recognised issue. The planned NRAP mandatory standard on streamlining rolling stock approvals is testament of one of these issues. However, European experience demonstrates that this cross-acceptance is critical to achieve Interoperability.

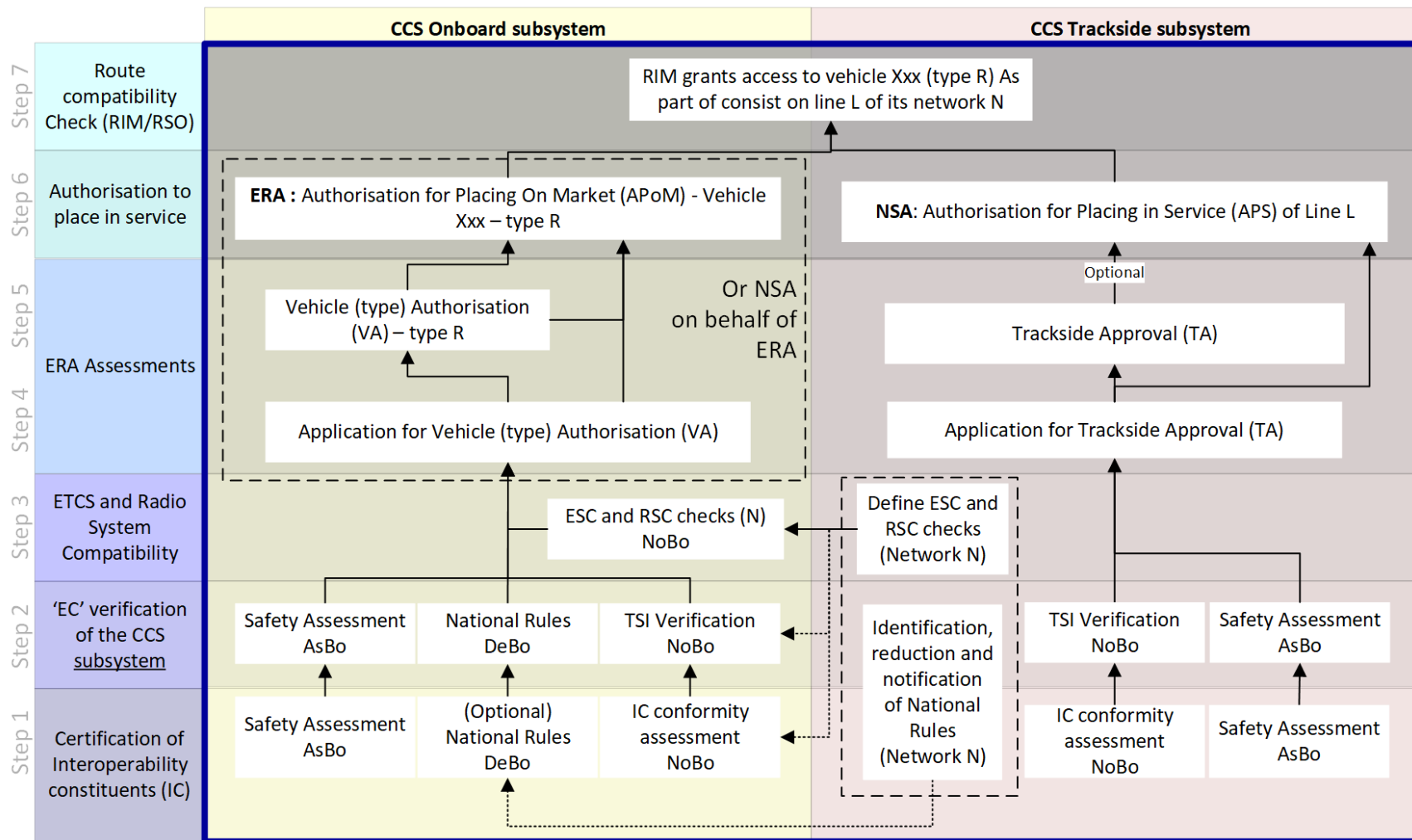


Figure 11. Overview of EU CCS Certification, and broader Approval and Authorisation process

6.2 Requirements for DTCT Certification, Assurance and Approval

Figure 12 illustrates the possible framework for DTCT certification, assurance and approval process on the NNI, based on the options put forward in the following sections. It draws a parallel with the EU processes outlined in the TSI for CCS subsystems as represented on Figure 11. Differences between the 2 are highlighted in red, and activities over a grey background either already exist or will be covered by other standards.

Figure 12 provides an overview to help navigate through the following sections which will describe in more detail each of the activities proposed and where targeted feedback will be asked.

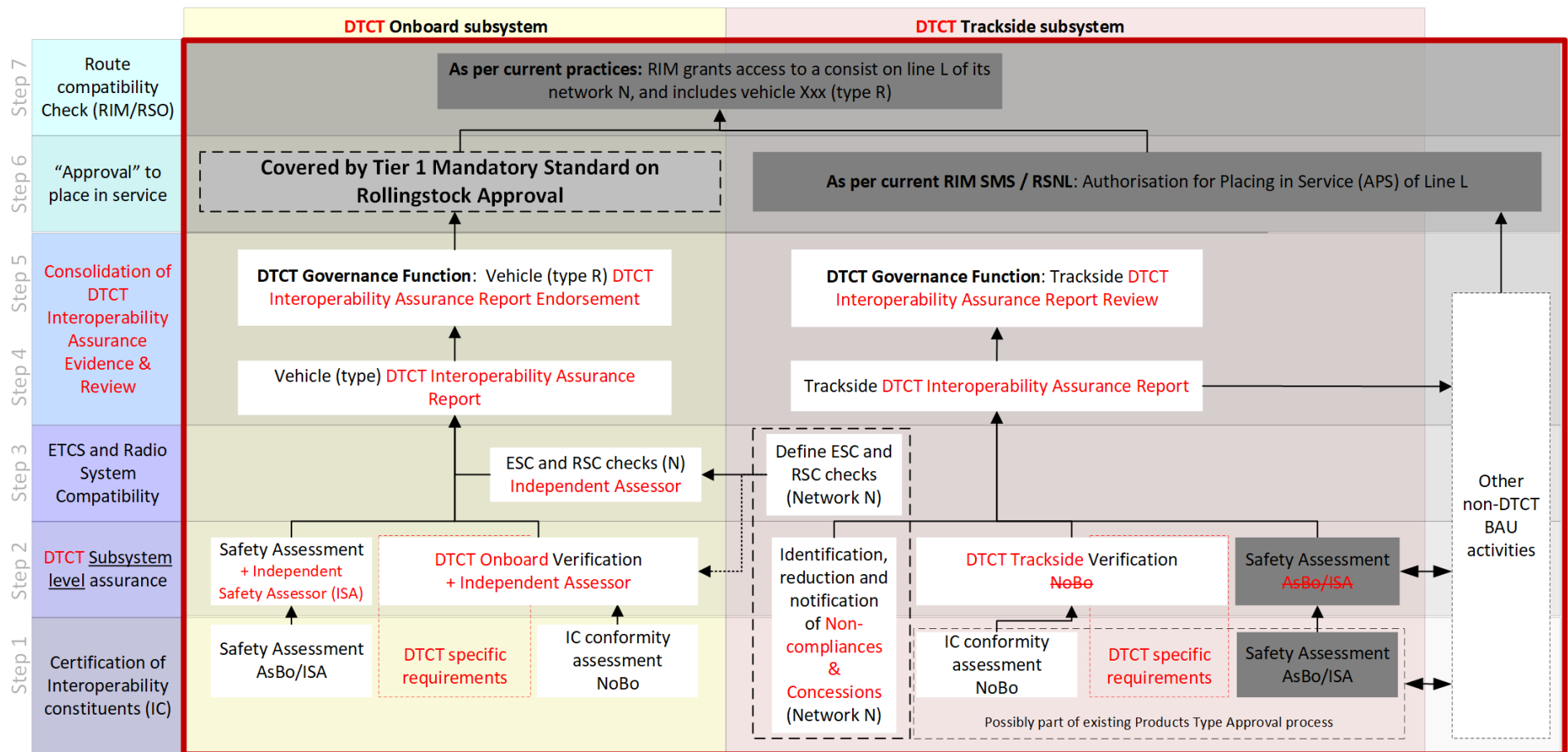


Figure 12. Possible framework for DTCT certification, assurance and approval process

6.2.1 Framework for cross-acceptance

As noted in section 6.1, the Australian rail sector has no applicable framework across all states. This absence of a standardised framework prevents stakeholders from contracting services from external assessment bodies with the assurance that the results (if positive) will be recognised across multiple jurisdictions. Consequently, assessments conducted in one jurisdiction may not be accepted by others.

Outsourcing services and cross-acceptance are closely linked, as independent assessors are commonly used to demonstrate the correctness and objectivity of activities performed by suppliers, operators, or infrastructure managers, thereby facilitating their acceptance by others. Therefore, it is essential to have a framework that permits the outsourcing of these independent assessments, ensuring that their conclusions and their independence are recognised throughout the Australian rail sector.

CENELEC reliability, availability, maintainability and safety (RAMS) standards (EN 50126 / IEC 62278 suites) are mandated by the TSI for the development of IC and also for the assurance at project level in EU. In Australia, the application of this suite of standards is given as an example to demonstrate adoption of good safety assurance principles by the Office of the National Safety Regulator (ONRSR) as part of its guideline for major projects (See Ref 12). In practice the application of EN50126 suite is already used across most jurisdictions in Australia for the demonstration of RAMS performance of products and technical systems performing safety functions such as signalling & train control systems.

These standards require the use of Independent Safety Assessors for products and systems with the level of complexity and safety criticality as the ones used in DTCT. The use of ISA is further supported by ONRSR which recommends their use as a good practice on major projects to rigorously oversee safety processes (See Ref 12). Therefore, ISA will become one of the key services to be externalised by entities implementing DTCT and will require adequate framework so that their conclusions are acceptable to other stakeholders. This is particularly true for the acceptance of assurance for Onboard DTCT subsystems across multiple networks. Other independent Interoperability assessment may also become necessary.

Cross-acceptance is a foundational pillar of the European Interoperability framework. In many aspects this framework is not specific to rail but relies on other legislative elements around product compliance certifications and the use of harmonised standards, in addition to railway specific requirements. Key elements of the EU framework aiming at promoting and supporting cross-acceptance include:

- The processes to be complied with, for each critical assurance and independent assessments (e.g. CSM-RA, Testing by independent laboratories, Application of CENELEC standards, EC Certification framework, etc.).
- Mutual acceptance criteria / risk framework for safety levels.
- Requirement on Quality Management Systems for these organisations.
- Competency Requirements for critical tasks.
- Audit requirements for independent assessment bodies.
- Accreditation of different entities by relevant European or National authorities

Some Australian RIMs and asset owners have implemented frameworks with similar purpose, to allow them to outsource engineering services for the planning, delivery, operation & maintenance of their assets on their fleets or networks. The Transport Assured Organisation framework

developed by Transport for New South Wales is an example of such framework but only applies to providers and services for NSW owned assets and is not officially recognised outside of NSW.

The Australian framework could build on this experience, to support services critical to eventually achieve Interoperability.

There is an opportunity to develop the framework required to support cross acceptance not solely for DTCT but to also mutualise it with the development of a mandatory standard for streamlining rolling stock approvals, and potentially other railway approvals seeking cross acceptance (e.g. Type Approvals, etc.).

This framework should be designed to support cross acceptance of certifications of DTCT solutions performed in Europe (and having followed due process).

6.2.2 Step 1: Trackside and Onboard DTCT IC / Product assurance and certification

The DTCT products are complex and play a key role in achieving interoperability. Therefore, evaluating the compliance of the Interoperability Constituents and products regarding the following aspects is crucial:

- Compliance to the specifications and requirements mandated from the TSI.
- Compliance to DTCT specific requirements not covered by CCS TSI:
 - any tailoring of the TSI, if mandated eventually by the DTCT standards (E.g. alternative DMI if it was decided to do so, Train Numbering, etc.).
 - any mandatory additional product level requirements, beyond the CCS TSI.

The first bullet point is the scope of the assurance and certification mandated in Europe. It is proposed that DTCT standards are developed with similar requirements as the ones defined in the TSI, so that demonstration of compliance performed on standard products can be reviewed and cross accepted in Australia, as has already been the case on many Australian ETCS implementations to date.

Given that the TSI specify the performance targets for the safety functions delivered by the IC, the demonstration of compliance includes safety and technical components to it, as it can be observed in the 2 proposed activities for each subsystems in Step 1 in Figure 12.

It is proposed for the standards to require the involvement of independent assessors (i.e. EU NoBo and ISA) to support the demonstration of compliance to the TSI by the IC. This is subject to the cross-acceptance of these assessments, as discussed in section 6.2.1, but the use of such assessor particularly for the onboard IC will maximise the cross acceptance during overall rollingstock approval process.



Question 17: Do you anticipate any issue if the DTCT standards mandate the involvement of independent assessors as part of the demonstration of compliance with the CCS TSI at IC/Product level, as it is the case in Europe?

Demonstrating compliance for the DTCT specific requirements is unlikely to ever be required outside of Australia. Therefore, requiring evidence at IC/Product level is not expected to be efficient for global suppliers and it is proposed that these demonstrations be produced at a higher level, i.e. at DTCT subsystem level, once configured for a given project.

It is acknowledged that at this stage, the number of DTCT specific requirements and the effort to demonstrate compliance with them, remain subject to the outcomes of the stakeholder engagement discussed in section 5. If for example the standards were to mandate new products or significant alterations of existing products (e.g. see section 5.2.3, etc.), this approach may be reconsidered and compliance demonstrations at IC/product level might be necessary.

Type Approval process (See Ref 13) used by RIMs could provide an opportunity to demonstrate compliance to DTCT specific requirements at product / IC level. It may be particularly interesting if the results of the type approval within one network were to be cross accepted by others.

However, Type approval and cross acceptance of trackside products / IC have an impact on productivity but not directly on Interoperability. As such it is not proposed for the DTCT Tier 1 standards to address further these aspects.

To date Type Approval process have been seldom used (if ever) for rollingstock subsystems or components in Australia and offers limited opportunity as-is to support cross-acceptance of compliance to DTCT specific requirements.



Question 18: Do you foresee any issue if the demonstration of compliance to DTCT specific requirements only happens at subsystem level?

Question 19: Are there existing or emerging frameworks which could be proposed to maximise cross-acceptance of demonstration of compliance for DTCT onboard products?

6.2.3 Steps 2 to 6: DTCT Trackside subsystems from subsystem assurance to placing in service

The approach put forward for the trackside subsystem relies heavily on the process defined by the CCS TSI but acknowledges the current co-regulation model and the accountability of the RIM for the safety and performance on their networks.

Step 2: DTCT Trackside Subsystem assurance

At this stage of the process RIM will need to demonstrate compliance that their DTCT trackside subsystem as configured for their project, meet the relevant TSI requirements and specific requirements (including technical, safety, etc.) defined in the DTCT Tier 1 Standards. This can typically rely on demonstrations already performed at IC / product level but also covers other requirements which could not be demonstrated before, including DTCT specific requirements such as TSI function tailored for DTCT, requirements from other TSI, change in intended context, etc.).

The difference between EU processes and the practice in Australia for trackside DTCT is that (to date) RIMs delivering trackside subsystems have had no obligations to demonstrate compliance to

standards beyond their own or that this demonstration involves some form of independence. In contrast, the Interoperability framework reflected in the TSI mandates the assessment and demonstration of compliance with the TSI, exceeding the requirements that RIMs may set for their own standards. Furthermore, the framework also requires the involvement of independent assessment bodies (known as a “Notified Body” or NoBo) to independently assess the compliance with the CCS TSI.

In line with the recent lessons learnt from the experience in the UK, as well as the current co-regulation approach in place in Australia, it is not proposed that the DTCT standards mandate such an additional level of independent assessment. RIM eventually remain accountable for achieving Interoperability on their networks and will consider the proposed presumption of compliance of the DTCT Onboard subsystems.

The DTCT standards are proposed to mandate for RIMs to perform all necessary checks for subsystems as outlined in the CCS TSI, including those usually carried out by independent assessors, as well as additional checks to cover the DTCT specific requirements.

The results of these checks should be documented in a manner consistent with TSI requirements, to support the review described in step 5.

Note that most of the checks required by the TSI would normally be performed by RIM following recognised engineering practices for systems of this complexity. Many of these checks are already being performed by current DTCT deployments. However, it is worth noting that the latest version of the CCS TSI mandates the need for onsite “operational scenario” testing (defined as system testing relevant to the engineering rules applied to the project) to be performed with at least two certified onboard subsystems from different suppliers addressing lessons learnt from previous deployment. This is not something currently considered by the RIMs (even if in networks like Sydney Trains’ it will happen de facto).



Question 20: Should the standards mandate for independent entities to certify the compliance of trackside subsystems with the DTCT Standards for all projects or in some circumstances (e.g. 1st project for a RIM, Project implementing a major change of DTCT principles, etc.)?

To rigorously oversee safety processes, it is expected that DTCT deployments will remain considered as “major projects” and implement recommendations from ONRSR major projects guidelines (see Ref 12) which include the use of ISA as a good practice on major projects.

As such ISA will oversee safety processes during DTCT trackside implementations, despite not being mandated by DTCT standards. Today it is already common practice for many RIM implementing DTCT trackside to use the services of an ISA to assess the safety assurance reports put forward by their system integrators and their Trackside subsystems providers.

Step 3: ETCS Systems Checks / Radio Systems Checks

The CCS TSI requires a RIM in Europe to identify any additional confidence checks they require CCS Onboard subsystems to perform and demonstrate before Vehicle (Type) Approval is granted.

These ESC/RSC are then consolidated by the ERA, which coordinates with the RIMs to rationalise and over time reduce such additional testing requirements. The notification and publishing of such testing requirements allows for suppliers to anticipate the request from the time when their products are developed and possibly certified (with independent assessment). This allows greater efficiency and minimises the level of testing in the late project stages.

ESC/RSC checks in EU are very focussed on checking specific configurations which have been known to be subject to different interpretation by stakeholders in the past (and still subject to occurring with older versions of CCS Onboard). The nature of the checks is decided by the RIMs, and can include desktop analysis, offsite testing and onsite testing, with a push by the sector to minimise as much as possible the need for onsite checks.

It is proposed that RIMs be required to identify and publish the Australian equivalents to the ESC and RSC checks (as defined in the CCS TSI) with respect to the DTCT standards.

ESC/RSC checks could also be used to consider non-compliances and concessions to the DTCT standards implemented on the area of the NNI managed by the RIM.

These checks could additionally take into account the context from other tracks on a RIM's network even if not on the NNI, but which could be accessed by Vehicles subject to the DTCT Onboard standard.



Question 21: Should the Australian ESC/RSC identified by the RIM be publish and coordinated nationally as it is the case in Europe?

Step 4 and 5: Consolidation of DTCT Interoperability assurance evidence and review

Similarly to step 4 in the EU framework, it is proposed that a dedicated assurance report is produced focusing at demonstrating compliance to the requirements from the mandatory DTCT standards.

To do so it is proposed that RIMs consolidate into a Trackside DTCT Interoperability Assurance report, all evidence required by the standards and underlying TSI, produced during the delivery of their project to demonstrate Interoperability requirements are met including:

- Relevant CCS TSI requirements listed in DTCT mandatory standards
- DTCT specific requirements
- Concessions
- Non-compliances

As explained in an earlier section, it is also proposed that the structure of this report is made consistent by the standards aligning as much as possible on existing structures from the EU Interoperability framework.

Aligning with lessons learnt and to keep learning from on-going ERTMS deployment overseas, it is proposed that RIMs include as part of their trackside DTCT Interoperability Assurance Report, the ERTMS functions and issues list developed and maintained by the ERA. It is currently used in

Europe to support Trainside Approval requests. This document consolidates a list of features and configurations which have been identified over time with higher risk to Interoperability or known issues with certain baselines.

The content and structure of the report will be further detailed during the development phase of the standard.

The evolution of the role of the ERA in Europe suggests that key information from across all DTCT trackside deployments is required to avoid late requirements and minimise bias in the demonstration of compliance by RIM as observed in the past. Currently in Europe, the framework has evolved so that RIMs must obtain a Trainside Approval (TA) performed by the ERA before obtaining an Authorisation to Place In Service by their National Safety Authorities. The ERA's review focusses solely on achieving interoperability at EU level and as such only assesses compatibility between trackside and onboards and checks that RIMs technical solutions envisaged are fully interoperable.

The TA process does not change the responsibilities of independent assessors (NoBos, AsBos) in verifying compliance with interoperability through certified components and EC verification process for the CCS subsystem (refer to Step 1 and 2). Similarly, it does not alter the NSAs' responsibility to Authorise to Place into Service (APS).

Experience from Europe has demonstrated the value of the ERA contributing to the review of the project compliance evidence (even if high level), even though the result of its analysis and recommendation is actually not mandatory prior to revenue service.

The involvement of the ERA's technical SMEs during these reviews is helping to detect possible risks to Interoperability early, in particular for RIM less experienced in implementing CCS, as well as improving quality of the TSI (developed by ERA).

Considering latest approach in Europe with respect to needing a broader Interoperability coordination, while acknowledging the accountability of the RIM on their networks, it is proposed that Trainside DTCT Interoperability Assurance Report are reviewed outside from the RIM organisation and that such review provides advice to the RIM.

The nature of the advice to be provided will be detailed during the development of the standards, but is intended to cover at least:

- Completeness and correctness of the assurance evidence provided by the RIM to demonstrate the conformity of their DTCT Subsystem.
- Analyse non-compliances and concessions to the mandatory requirements of the DTCT Standards proposed by RIMs and their possible impact on the broader NNI Interoperability.
- Develop or coordinate the development of artefacts gathering known DTCT interoperability "vulnerabilities", for RIM to consider as part of their assurance processes.

ERA's current role also contributes to the capitalisation and sharing of the lessons learnt by all the RIM and drive toward harmonised implementations. This provides great value, in particular to recent adopters that have a lesser engineering capability than early ETCS adopters.



Question 22: Do you see merit in coordinating nationally the review of Trackside DTCT Interoperability Assurance Report?

It is proposed that the standards mandate the following activities with their execution to be coordinated nationally:

- Manage and possibly centralise the publication of information from the RIMs relevant to delivering Interoperable DTCT Onboard subsystems,
- Collect that information and analyses of non-compliances, concessions and implementation issues encountered during the deployment of DTCT trackside,
- Make that information available to relevant actors within the rail sector.

The nature of these artefacts, and the mechanisms for sharing across RIMs and RSOs to support this knowledge sharing, should be considered once the nature of the coordination function is known.

Step 6: Placing trackside subsystems in Service

Provisions under RSNL and practices recommended by ONRSR are expected to be sufficient to support the Interoperability of trackside subsystems provided that the recommendations above are adopted. Hence, it is not proposed to change RIM accountability to place their assets in service for areas included on the NNI.



Question 23: Can you provide further feedback on the approach for assurance of Interoperability of DTCT trackside subsystems? How do you perceive the balance between aligning with the EU framework and incorporating lessons learnt in Europe, while still retaining RIMs accountability for decisions on their network?

6.2.4 Steps 2 to 6: DTCT Onboard subsystems from subsystem assurance to placing in service

As discussed in earlier sections of this document, the current Interoperability framework in Europe for the assurance and approval of the onboard subsystems aligns to the following principles:

- CCS Onboard IC, subsystems and interfaces are strictly complying to the (detailed) CCS TSI.
- Assurance and certification of conformity are performed at different levels and finalised for a vehicle type, following a framework which supports cross-acceptance.

- Once conformity to the TSI is demonstrated and safety is also demonstrated (to a set of targets acceptable to all European rail sector), a single “Authorisation to Place on Market” (i.e. in service) is delivered for the vehicle by a centralised entity (ERA or NSA on its behalf).

It is acknowledged that this last item represents a significant deviation from the current co-regulation approach in force in Australia.

The strategy put forward in the following sections for the onboard subsystem relies heavily on the process defined by the CCS TSI and the European Interoperability Framework. It aims to effectively balance the current co-regulation model and the accountability of the RSO for the safety and performance of their assets. This approach acknowledges that introducing onboard DTCT will contribute to reducing safety risks on each network where these vehicles operate, and that such residual risks are currently accepted by each RIM.

A key distinction between the onboard subsystem and trackside subsystem contexts is the requirement for the overall assurance evidence of an onboard subsystem to be acceptable for all RIM on the NNI. This need for cross-acceptance has lead EU to mandate over time a higher number of independent assessments for the onboard subsystem than it is proposed for the trackside. These independent assessments should be subject to the establishment of a framework as discussed in section 6.2.1.

In Australia, the current processes to secure approval for rolling stock to operate across multiple networks are characterised by:

- inconsistency,
- the need to reformat evidence to suit different networks, and
- the lack of cross acceptance of approval outcomes by other RIMs.

DTCT onboard subsystems are complex operational and safety critical systems, which are relied on by RIMs to achieve the overall system performance targeted for their networks. It is essential that the current complexity of rollingstock approval is resolved to allow an aligned approach to DTCT onboard approvals and cross-acceptance. It is proposed that the DTCT Standards and the mandatory Rollingstock Approval standard are developed consistently and avoid duplicating or diverging requirements.

It is proposed that the DTCT Onboard standard primarily focuses on

- The operational and technical requirements
- The assurance requirement to support demonstration of conformity to the DTCT standards
- The format and structure of the evidence required.

Additionally, it is proposed that the Rollingstock Approval standard develops:

- Elements supporting cross-acceptance illustrated in Figure 12 as these are not specific to DTCT.
- The need to grant a single approval that is applicable nationally.

Step 2: DTCT Onboard subsystem assurance

Similar to trackside deployments, RSOs will need to demonstrate compliance that their DTCT onboard subsystem as configured for their project (on a per vehicle or class basis) meet the relevant TSI requirements and specific requirements (including technical, safety, etc.) defined in the DTCT Tier 1 Standards. This demonstration can typically build on evidence already performed at IC / product level but must also address additional requirements that could not be previously demonstrated. These include DTCT-specific requirements such as TSI tailored functions, requirements from other TSIs, changes in the intended context, and more.

Feedback from the experiences in the UK and Europe indicates that when interoperability issues are encountered, it is generally assumed that the CCS Onboard subsystems comply with the TSI (unless otherwise demonstrated by the RIM).

To balance this bias toward Onboard subsystem and acknowledging the additional complexity to rectify subsystems on moving vehicles if needed, both UK and the EU Interoperability framework identified a greater need for the involvement of independent assessment entities during the initial delivery of a vehicle type to assure the strict compliance to the TSI.

It is suggested that RSOs, potentially in collaboration with independent entities, perform all necessary checks outlined in the CCS TSI for onboard subsystems including the local application of the ESC/RSC concept.

Note that most of the checks required by the TSI would normally be performed by entities following recognised engineering practices for systems of this complexity. Many of these checks are already being performed by existing DTCT deployments.

Similar to trackside demonstrations, it is recommended that the results of the checks be documented in a manner consistent with TSI requirements.

Question 24: If used, what level of activities at subsystem level would you recommend being performed by entities independent from RSOs:

- Testing and certification against technical and operational requirements of the Onboard DTCT standard similar to what is being done by NoBos in Europe?
- Assessment of the compliance evidence produced by the RSO and their suppliers?
- Other activities?
- None of the above, as it is the case today for other rollingstock subsystems.

Independent entities would be subject to complying with the framework to be defined as part of the mandatory rollingstock approval standard. These entities could be other RIM or RSO (e.g. where 1st certification happens), or dedicated entities.

Depending on the extent of the specific Onboard DTCT requirements, additional checks may be necessary beyond the ones specified in the CCS TSI

It is proposed that the development of complementary checks for specific Onboard DTCT requirements be coordinated nationally. This could include the requirement for the testing environment (whether offsite or onsite testing is required) in which these checks are to be performed.

As noted in section 5, some requirements from the DTCT standards may be adopted from TSI other than the CCS TSI. It is not proposed to require demonstrating complete compliance to these other TSI, but only to selected requirements.

Safety compliance

As explained in other sections, the applicable requirements from the CCS TSI referenced by the DTCT Standards will specify the minimum integrity level for the safety functions, and compliance must also be demonstrated. It is expected that the introduction of DTCT on vehicles will be considered as a “major project” and that the safety assurance reports provided by RSO’s system integrators (and their DTCT Onboard subsystems providers) will be subject to review by an Independent Safety Assessor (ISA). This approach aligns with the recommendations from the major projects’ guideline published by the Office of the National Rail Safety Regulator (see Ref 12).

Note that the cross-acceptance of safety demonstration and their independent assessment by an ISA, would rely on some form of cross-acceptance framework, which does not currently exist in Australia (see section 6.2.1).

Note: In Europe, an important aspect of the cross-acceptance is that the residual safety risks are demonstrated to be reduced to a level which is ‘reasonably practicable’ to all RIMs across Europe. This is achieved by having agreed and legislated a set of Common Safety Targets as part of the Railway Safety Directive.

These Common Safety Targets have been used to derive the Tolerable Hazard Rates mandated in the CCS TSI for the safety functions of the CCS subsystems and their interfaces.

Note that if specific safety functions were to be required by the Onboard DTCT standards beyond the ones specified in the CCS TSI, the definition of their minimum safety integrity level could possibly suffer from the absence of these common targets. This will have to be considered during the development of the DTCT standard.

Question 25: Should the standard require the use of Independent Safety Assessor and compliance to CENELEC RAM and Safety standards, including the content and structure of the safety cases to be produced, to support cross acceptance of these evidence?

Step 3: ETCS Systems Checks / Radio Systems Checks

As identified in section 6.2.3, RIMs will be required to identify and publish additional checks to be performed to support the demonstration of the compatibility of a vehicle operating on their networks. These checks can go beyond the TSI requirements, and can include checks related to non-compliance or concessions, previous issues or differences observed between suppliers, etc. These tests relate to specific DTCT configurations on their networks and are mandated to follow the ESC and RSC process defined in the CCS TSI but may well extend to the specific DTCT requirements.

Given the local nature of these checks, it is expected that most if not all of them will only be performed at subsystems level and not IC / product level.

It is proposed that RSOs perform ESC and RSC identified and notified by the RIMs managing networks on the NNI and that the different arrangement proposed and adopted within step 2 apply.

Step 4 and 5: Consolidation of DTCT Interoperability assurance evidence and review

Similarly to step 4 in the EU framework, it is proposed that a dedicated assurance report is produced focusing at demonstrating compliance to the requirements from the mandatory DTCT standards.

To do so, it is proposed that RSOs consolidate into an Onboard DTCT Interoperability Assurance report, all evidence required by the standards and underlying TSI, produced during the delivery of their project to demonstrate Interoperability requirements are met including:

- Relevant CCS TSI requirements listed in DTCT mandatory standards
- DTCT specific requirements
- Concessions
- Non-compliances
- Safety case supporting compliance to safety requirements

As explained in an earlier section, it is also proposed that the structure of this report be standardised by aligning as closely as possible with existing structures from the EU Interoperability framework.

The ERA in Europe is performing two roles when processing request from applicants for a Vehicle Approval:

- Technical and administrative review of the compliance of the Vehicle (type) to the different requirements from the relevant TSI, the Railway Interoperability Directive and the Safety in Railway Directive.
- Acts as a centralised entity authorising the placing in service of the vehicle for operation across multiple networks.

The role of the ERA is much broader than dealing with the vehicle compliance to the CCS TSI, as it covers all TSI but also the safety management systems of the RSO and changes required to them due to the introduction of the new vehicle type. The latter aspect is covered by the issuance of single safety certificates.

The discussion thus far in this document only focuses on the aspects related to the compliance to DTCT standards, and leaves safety accreditations, and rolling stock approvals for other standards.

Lessons learnt from Europe show the value of having the ERA review the evidence of conformity to the TSI (despite some of them already being certified independently) and approve the compliance of the Vehicle types to the standards. The ERA is legislated to do so but also works with the different RIMs/State Regulators to put forward a robust and trustable framework so that the outcome can be accepted by all.

The involvement of the technical SMEs from the ERA during these reviews is helping to detect possible risks to Interoperability early as per trackside subsystems.

It is proposed that the standard mandates the following activities to be performed independently from the RSO and are coordinated nationally:

- Analyse, consult with RIMs and accept non-compliances and concessions to the mandatory requirements from the DTCT Standards proposed by RSOs.
- Review and endorse the Onboard DTCT Interoperability Assurance Report supporting alteration of existing DTCT or introduction of DTCT onto new classes of rollingstock.

This approach is similar to the one put forward for DTCT trackside with the noticeable difference that it proposes that the report is endorsed by the reviewing entity.

The development of the standard should consider the need or not of a national coordination when reviewing or certifying each individual vehicle, but at this stage its main involvement is envisaged for the certification of the of DTCT within vehicle type / class.

Question 26: Who would you see best place to independently review and endorse these reports? For example, other RIM or RSO (e.g. where 1st certification happens), or dedicated entities...

It is proposed that the standard mandates the following activities, but their execution is coordinated nationally:

- Collect information and analyse non-compliances, concessions and implementation issues encountered during the deployment of DTCT onboard and make the information available to relevant actors within the rail sector,
- Coordinate and possibly centralise the publication of information from the RSOs relevant to delivering Interoperable DTCT Onboard subsystems.

The development of the standard should investigate the details of the information to be collected and maintained. This should focus on the information required to successfully support the seamless integration of a vehicle type onto a trackside subsystem, but also any information RIMs, may require optimising their networks and deployments. This may include geometric features of the vehicles relevant to DTCT (e.g. antenna position underframe, etc.), DTCT versions, values assigned to specific ETCS variables, etc.

Step 6: Placing onboard subsystems in Service

Provisions under RSNL and practices recommended by ONRSR are expected to be sufficient to support the interoperability of onboard and trackside subsystems, provided that a suitable framework to ensure compliance with the DTCT standard is in place. Hence, it is proposed that RSO remain accountable to place their assets in service.

The approval of vehicles to operate on areas of networks forming part of the NNI is left for discussion during the consultation regarding the emerging mandatory standard for Rollingstock Approval.



Question 27: Is the approach put forward to ensure Interoperability of DTCT onboard subsystems adequately balance the risks and lessons learnt identified in Europe, while leaving RSOs accountable for the decisions on their vehicles.

6.2.5 Step 7: “Route Requirement checks”

The “route requirement checks” illustrated in step 7 from Figure 11 and Figure 12, is not specified in the CCS TSI, but instead in the TSI OPE.

Similar processes already exist in Australia between RSOs and RIMs when seeking authorisation for a train (i.e. 1 or multiple vehicles) to routinely access a network. This process covers much broader aspects than DTCT and are not expected to be materially changed.

The development of the interoperability standards will need to investigate the detail of DTCT Onboard information that a RIM may request from RSOs, aligning where possible with the definition given in the TSI OPE, also considering the specificities of DTCT in the Australian context.

Note that the requirement for the trains to be equipped or not with a compliant (to the CCS Interface requirements) Train Integrity Monitoring System, is considered in Europe as part of the route compatibility check, and not as a mandatory requirement subject to the conformity assessment.

7 Ongoing Interoperability Management

Establishing an effective framework for interoperability will require not only alignment on a solution, but also a way of managing that alignment over time to accommodate change in technology, deployment plans, manage points of disagreement and maintain the standards and requirements expected of individual rail entities.

Given the “rapidly” changing nature of DTCT and the extended period it will take to rollout across such a large and diverse network as the NNI and its associated fleet, it is important to develop a framework tailored to support the rail sector in managing real world issues encountered during deployment and evolutions.

This section also outlines some functions which could require national coordination.

7.1 Oversight, coordination and governance

Achieving Interoperability in Australia will require more than “just complying with the TSI”, and part of this will be to establish some form of governance to coordinate DTCT interoperability and related initiatives in Australia.

In Europe, the relevant governance entity is the ERA, which identifies the following as its primary tasks:

- Promote a harmonised approach to railway safety
- Devise the technical and legal framework in order to enable removing technical barriers, and acting as the system authority for ERTMS and telematics applications
- Improve accessibility and use of railway system information
- Act as the European Authority under the 4th Railway Package issuing vehicle (type) authorisations and single safety certificates, while improving the competitive position of the railway sector. This can however be delegated to National Safety Authorities issuing certificates on behalf of the ERA.

The ERA has internal technical capability but is supported by a range of other entities including representative bodies such as:

- UNISIG representing suppliers. It is the main contributor for the development, maintenance and updating of the ETCS and ATO technical specifications.
- EEIG “ERTMS user group”, representing European RIM and a key contributor to the technical specifications.
- RSO and vehicle owners, represented by several groups and are consulted during the development of the technical specifications.
- UIC leading and coordinating the development of the technical specifications for FRMCS on behalf of ERA.

Other representative bodies (e.g. independent assessors, national safety authorities, etc.) also contribute to the governance of the TSI.

Because of the use of ETCS in Australia, the functions of the ERA in relation to managing the ETCS and FRMCS specifications are directly applicable and need not be replicated locally. However, as set out in the discussion in the foregoing sections, there are many areas where a national coordinated view will be essential on how DTCT is to be applied and managed.



Question 28: Considering the NNI and broader Australian rail context, how do you think national coordination can be undertaken to ensure DTCT interoperability between RIMs and RSOs?

7.2 Managing changes in the DTCT standards

DTCT mandatory requirements could evolve due to multiple aspects:

- Changes to the underlying European TSI, whether it is due to a new official release, or the official interim publication by the ERA of “Error” correction.
- Changes to aspects of the requirements not related to the TSI, but rather Australian specific needs, either to introduce new requirements or correct errors encountered during deployment.

In both cases the experience in Europe has proven that it is critical to consult with stakeholders and carefully consider the broad impact of the changes beyond just addressing the needs of a few, to manage changes effectively.

As such, the suggestion is to manage the identification of the applicability of TSI clauses to Australia within the standards as this forms the basis for the rest of the mandatory requirements and evolves nowadays relatively infrequently.

Any changes to the CCS TSI and their adoption by the DTCT standard should be analysed at national level following due process and consultation. The outcome should be made official through an update of the standard or as an interim update of the DTCT standards using a dedicated mechanism similar for example, to the “Technical Notes” issued by TfNSW or “Technical Opinion” issued by the ERA.

Similarly, and as already recommended in section 5.1.1, the error corrections issued by ERA should not be made automatically mandatory by the DTCT standard (as is expected from the TSI), but its application across the NNI shall be coordinated nationally following due process and consultation.

As identified through the lessons learnt, it is recommended that some form of official communication channels with the ERA are established, and possibly coordinated nationally, to seek technical expertise, insights and return on experience on some of the aspects related to the CCS and dependencies from other TSI.

7.3 Managing other DTCT information to support Interoperability

It is anticipated that the introduction of DTCT across multiple RIMs and RSOs, particularly for those experiencing their first in-cab signalling transformation, will require flexibility in the definition and alignment of some of the mandatory requirements.

With the progressive introduction of DTCT on the NNI, there will be many separate projects (trackside and onboard) that will implement DTCT assets. Without active coordination, these separate projects may proceed independently despite the technical interdependencies they may have, and despite the presence of mandatory standards that are aimed at ensuring interoperability.

To achieve the flexibility and reactivity required, it is recommended that the standards mandate that the requirements for all adaptations of the TSI and additions for the Australian context are coordinated nationally following due process and consultation, even if probably streamlined compared to managing changes of the standards themselves.

National coordination will be required to manage and publish:

- Technical specifications, to ensure local adaptations are defined enough so they appear seamless to operating staff.
- Operational and functional principles to ensure that train operations under DTCT are defined enough so they appear seamless to operating staff (see section 5.5)
- Reference designs

Information from relevant DTCT deployments are to be recorded nationally to support decision making around DTCT integration on the NNI and its associated fleet. The nature and extent of such information could include for example:

- DTCT standards version (and underlying CCS baselines) implemented on trains and areas of the NNI.
- DTCT non compliances implemented on trains and network areas.
- Resolution of technical queries on DTCT requirements (e.g. interpretations, etc.).
- Register of specific variables and values.

The intention is to collaborate with RIMs and RSOs to make the relevant information available, without managing the configuration of the DTCT assets on behalf of the accountable entities.

7.4 Futureproofing

The features and timeline for inclusion of future innovations into the CCS TSI will depend on ongoing research, development, and standardisation efforts within the rail sector.

Due to specific national requirements (for example, in non-urban areas), Australian rail entities may need to focus on specific key areas of innovation to be integrated early into its DTCT standards. As discussed in section 1, some of the functions which may be desirable may not yet be standardised as part of the TSI (e.g. use of public mobile networks, virtual balises, etc.) or may not be intended to be specified by the TSI if not directly impacting Interoperability (e.g. Train Integrity Management Systems, etc.).

Several approaches could be considered to incorporate these specific needs and innovations while not yet fully integrated into the European CCS TSI originally mandated by the DTCT Standards:

- Wait for the development of functions in Europe, then a future release of the CCS TSI, in order to mandate the necessary functions for DTCT in Australia. This may lead to delays in Australia's DTCT deployment due to the time for development of a standard solution elsewhere, plus update of the TSI two consequences:
- A phased approach to allow for gradual integration of innovations. For example: Installing balises initially, i.e. starting with conventional approach with a roadmap toward migrating to virtual balises once this function is standardised.
- Invest in research and development to advance the readiness of the required technologies ahead of development in EU. These investments can accelerate the development of solutions tailored to the Australian rail environment, noting some Australian private projects such as Roy-Hill already have some of the required innovations (Satellite with virtual balises) albeit from a single supplier.

Many DTCT enhancements required by RIMs or RSOs to achieve their objectives will necessitate matching functions to be implemented by one or several of their industry counterparts. This will require coordination between stakeholders across the sector. Evolutions / enhancements could be classified into three categories:

1. Individual evolutions required by one or limited numbers of RIM/RSO and not requiring to be capitalised across the NNI.
2. Activation of functions by RIM or RSO which either require critical areas of the NNI or critical mass of its fleet to be equipped or upgraded.
3. NNI wide evolutions required by multiple RIMs or RSOs warranting in the long term an inclusion in the mandatory requirements when justified.

7.5 Coordinating deployment plans between RIMs and RSOs

The CCS TSI states that Member States (in Europe) shall draw up National Implementation Plans (NIP) describing their actions to comply with the CCS TSI, setting out the steps to be followed for the implementation of fully interoperable CCS subsystems.

These plans are used at higher level to coordinate deployment across networks and fleet, outside of the technical governance provided by the ERA. A summary from 2018 can be found in the "Synthesis report on NIP"¹⁰.

It is proposed that the coordination of the DTCT deployment plans be supported nationally to maximise the Interoperability on the NNI.



Question 29: Do you believe that the functions outlined in section 7 to be coordinated nationally are appropriate?

¹⁰ https://transport.ec.europa.eu/document/download/643683da-a488-4ba7-8af3-4fdeb0ee11cd_en?filename=20180302-synthesis-report-on-nip.pdf

8 Allocation of interoperability requirements

This document set out to examine the different aspects that will be necessary to achieve interoperability, addressing both the trackside and onboard components of DTCT, to provide context and rationale for the content to be developed for each of the discussion papers on individual standards.

This chapter provides a summary of how the various requirements for interoperability should be addressed, whether in one of the proposed standards, via the national governance, or by some other means.

The sections above analyse the requirements for interoperability considering technical, deployment and governance aspects. Whilst it will be essential that all the items discussed are addressed to ensure interoperability can be established and maintained, the appropriate means of addressing these issues sits between one of three mandatory standards, the operation of a national governance and the impacted RIMs and RSOs.

Question 30: Are there any essential items required in the future to achieve Interoperability which are missing from the list summarised in Table 11, and is the proposed allocation adequate?

Table 11 provides a summary of the proposed allocation of interoperability requirements.

Item	Addressed by
TSI Alignment	
Areas of the CCS TSI that are mandatory and areas that are not relevant for Australia	DTDT Trackside standard (trackside items) DTCT Onboard standard (onboard items)
Areas of other TSIs that are mandatory	DTDT Trackside standard (trackside items) DTCT Onboard standard (onboard items) National governance
Version(s) of the TSI to be deployed onboard	DTCT Onboard standard (onboard items) National governance

Item	Addressed by
Version(s) of the TSI to be allowed for trackside	DTDT Trackside standard (trackside items) National governance
Mandatory deviations to the TSI	National governance
Additional mandatory functions of the DTCT not addressed in TSI	DTDT Trackside standard (trackside items) DTCT Onboard standard (onboard items) National governance
Response to Technical Opinions published by the ERA	National governance
Interface to the ERA on behalf of Australian RIM / RSO	National governance
ETCS functions not to be used	DTCT Trackside standard (trackside items) DTCT Onboard standard (onboard items)
Acceptable ETCS variables	DTCT Trackside standard (trackside items) DTCT Onboard standard (onboard items)
Radio requirements	DTCT Trackside standard (trackside items) DTCT Onboard standard (onboard items)
Preferred ETCS trackside arrangements, including applicable ETCS variables	DTCT Trackside standard National governance
Implementation	
Certification and Assurance requirements	DTDT Trackside standard (trackside items) DTCT Onboard standard (onboard items) National governance

Item	Addressed by
Approval process for DTCT onboard	Alignment of Rolling Stock Approvals standard
List of accepted entities for Assurance, testing and certification for DTCT onboard	National governance
Maintain register of DTCT deployment details	RIM, RSO (as relevant) National governance (consolidated for NNI)
Acceptance of non-compliance and concessions to DTCT standards	National governance
Manage and Maintain Interoperability	
Update DTCT standards	National governance
DTCT Strategy	National governance
Coordinate ETCS deployment plans	National governance
Resolve conflicts and disputes	National governance

Table 11. Allocation of interoperability requirements to standards and other mechanisms

List of questions

- Question 1:** Are there any change to the definition of Interoperability and DTCT you would like to be considered for the Australian context? 18
- Question 2:** Do you foresee any of the lessons learnt to be particularly problematic for Australian railways? 27
- Question 3:** Are there any key considerations missing or alternatives that should be investigated on the proposed approach for managing DTCT baselines and error corrections? 35
- Question 4:** Should the standards identify functions within the CCS TSI that are not to be used in Australia or on the NNI, if agreed at national level? 40
- Question 5:** Are you aware of any existing non-compliant functions that could impact interoperability of networks if not incorporated into the standards? 41
- Question 6:** Should non-standard use of ETCS parameters remain permitted for captive fleets so long as non-captive vehicles using the NNI and not implementing the onboard customisation can traverse the network without impact? Are there some non-standard use of ETCS parameters already identified and implemented which would warrant a national application or could jeopardise Interoperability if not modified? 45
- Question 7:** Should functional customisations remain permitted on the NNI, so long as non-captive vehicles using the NNI and not implementing the onboard customisation can traverse the network without impact? Are there some functional customisations already identified and implemented which would warrant a national application or could jeopardise Interoperability if not modified? 46
- Question 8:** What successful frameworks, implemented globally or locally, can be used during the development of the standards to reach a conclusion which best balances: 48
- Question 9:** What critical dependencies from other disciplines might be missing, and what is your feedback on the proposed approach to manage them in the mandatory standards? 49
- Question 10:** What are other dependencies that need to be identified, and what is your feedback on the proposed approach for their inclusion in the mandatory standards? 55
- Question 11:** Do you agree on the proposed approach for managing radio capability on the trains? 60
- Question 12:** Do you agree with the proposed approach for managing the migration of GSM-R to FRMCS while rolling out ETCS on the NNI areas currently covered by GSM-R? 62
- Question 13:** Do you agree on the proposed approach for managing the interconnection of railways private radio networks and their separation from the NTCS? 63
- Question 14:** Do you think it is viable to align DTCT principles to achieve alignment of operational rules: 67

- Question 15:** Do you support the proposed approach to apply DTCT Onboard standard to all vehicles which nominally operate over any part of the NNI? If not, what is the reason for such answer? 68
- Question 16:** Do you support the approach to restrict the applicability of the DTCT trackside standard only to tracks part of the NNI and those supporting entry and exit from the NNI? If not, what is the reason for such answer? 69
- Question 17:** Do you anticipate any issue if the DTCT standards mandate the involvement of independent assessors as part of the demonstration of compliance with the CCS TSI at IC/Product level, as it is the case in Europe? 77
- Question 18:** Do you foresee any issue if the demonstration of compliance to DTCT specific requirements only happens at subsystem level? 78
- Question 19:** Are there existing or emerging frameworks which could be proposed to maximise cross-acceptance of demonstration of compliance for DTCT onboard products? 78
- Question 20:** Should the standards mandate for independent entities to certify the compliance of trackside subsystems with the DTCT Standards for all projects or in some circumstances (e.g. 1st project for a RIM, Project implementing a major change of DTCT principles, etc.)? 79
- Question 21:** Should the Australian ESC/RSC identified by the RIM be publish and coordinated nationally as it is the case in Europe? 80
- Question 22:** Do you see merit in coordinating nationally the review of Trackside DTCT Interoperability Assurance Report? 82
- Question 23:** Can you provide further feedback on the approach for assurance of Interoperability of DTCT trackside subsystems? How do you perceive the balance between aligning with the EU framework and incorporating lessons learnt in Europe, while still retaining RIMs accountability for decisions on their network? 82
- Question 24:** If used, what level of activities at subsystem level would you recommend being performed by entities independent from RSOs: 84
- Question 25:** Should the standard require the use of Independent Safety Assessor and compliance to CENELEC RAM and Safety standards, including the content and structure of the safety cases to be produced, to support cross acceptance of these evidence? 85
- Question 26:** Who would you see best place to independently review and endorse these reports? For example, other RIM or RSO (e.g. where 1st certification happens), or dedicated entities... 87
- Question 27:** Is the approach put forward to ensure Interoperability of DTCT onboard subsystems adequately balance the risks and lessons learnt identified in Europe, while leaving RSOs accountable for the decisions on their vehicles. 88
- Question 28:** Considering the NNI and broader Australian rail context, how do you think national coordination can be undertaken to ensure DTCT interoperability between RIMs and RSOs? 90

Question 29: Do you believe that the functions outlined in section 7 to be coordinated nationally are appropriate? 92

Question 30: Are there any essential items required in the future to achieve Interoperability which are missing from the list summarised in Table 11, and is the proposed allocation adequate? 93

Glossary

Table 12. Glossary of terms

Term	Definition
3GPP	3rd Generation Partnership Project
AoE	Automatic Train Operation over ETCS, one of the constituents of ERTMS. The European specified ATO specified to integrate with ETCS and support the Interoperability objectives.
ARA	Australian Railway Association
ARTC	Australian Rail Track Corporation
AsBo	The independent Assessment Body (AsBo) carries out an independent safety assessment of the correct application of the risk assessment process, of the results of that process and of the safety demonstration of the system under assessment in order to provide additional assurance that the necessary level of safety can be achieved. The following organisations or entities can act as AsBo: (a) a competent external or internal (i.e. in-house) individual, organisation or entity which is at least independent from the "design, risk assessment, risk management, manufacture, supply, installation, operation/use, servicing and maintenance" of the change under assessment. (b) a national safety authority (NSA), an OTIF national authority competent for technical admission, an EU notified body (NoBo), an EU designated body (DeBo), an OTIF assessing entity.
CCS	Control-Command Signalling subsystem. One of the functional subsystems identified in Europe to achieve Interoperability.
CENELEC	European Committee for Electrotechnical Standardisation
CSM	Common Safety Methods

Term	Definition
DeBo	"Designated Body." A Designated Body is an entity appointed by a member state of the European Union to assess the conformity of subsystems with national technical rules. This is part of the process to ensure that railway systems are interoperable across different countries, adhering to both European and national standards. The DeBo plays a crucial role in verifying that the specific national requirements are met, complementing the work of the Notified Bodies (NoBos), which assess compliance with European standards.
DTCT	Digital Train Control Technology as defined in section 2.4
EC	European Commission
EMC	Electro Magnetic Compatibility
ERTMS	European Rail Traffic Management System (also known as CCS). It is composed of 3 functional subsystems as ETCS, RMR and AoE.
ETCS	European Train Control System, one of the constituents of ERTMS.
ESC	ETCS System Checks. Defined in the TSI, as mechanism for RIM in EU to define specific demonstration above standard compliance to the TSI to reflect specific features of ETCS on their network.
FRMCS	Future Railway Mobile Communication Systems, one of the constituents of RMR.
GSM-R	Global System for Mobile Communications – Railway, one of the constituents of RMR.
IM	Infrastructure Manager (RIM in European context)
Interoperability	As defined in section 2.3
ISA	Independent Safety Assessor

Term	Definition
LTE / 4G	Long Term Evolution. Mobile broadband radio technology related to 4G standards.
NNI	National Network for Interoperability (https://www.ntc.gov.au/project/national-network-interoperability)
NoBo	Notified body (NoBo) notified for the assessment of conformity of a structural sub-system against the relevant Union law (TSIs). The NoBo provides thus an independent assessment of the technical compliance with the relevant Union law (TSIs).
NRAP	The National Rail Action Plan (NRAP) program is reducing differences across networks and driving harmonisation to improve interoperability. A big focus of this work is to make it simpler and easier to get trains moving seamlessly across networks by streamlining the rolling stock approval process.
NRSF	National Rail Standards Framework.
NSA	National Safety Authority (Safety regulator in European context)
NTCS	National Train Communication System (NTCS), using Telstra public mobile network to provide service for ARTC.
NTSN	National Technical Specifications Notices. UK selected approach to support the implementation of European TSI after 2020.
ONRSR	Office of the National Rail Safety Regulator
RIM	Rail Infrastructure Manager, as defined in the RSNL
RINF	The Register of Infrastructure referred to in Article 35 of Directive 2008/57/EC indicates the main features of European rail network fixed installations, covered by the subsystems: infrastructure, energy and parts of control-command and signalling. It publishes performance and technical characteristics mainly related to interfaces with rolling stock and operation.

Term	Definition
RMR	Radio Mobile for Railways, one of the constituents of ERTMS. The European specified radio specified to integrate with ETCS and AoE in order to support the Interoperability objectives. It is based on 2 distinct technologies GSM-R and the upcoming FRMCS, and support multiple functions which main ones are – operational voice services and – data transmission for ETCS and AoE.
RSC	Radio System Checks. Defined in the TSI, as mechanism for RIM in EU to define specific demonstration above standard compliance to the TSI to reflect specific features of RMR on their network.
RSNL	Rail Safety National Law, 2012 (South Australia)
RSO	Rolling Stock Operator
RTO	Rail Transport Operators, e.g. a RIM or an RSO as defined in the RSNL
RU	Railway Undertaking (RSO in European context)
SFAIRP	So Far As Is Reasonably Practicable, as defined in the RSNL
SOI	Single On-Board Interface for Drivers and Crew Standard for Interoperability Former name used for what is now renamed as DTCT Onboard Standard.
STM	Specific Transmission Module. Device allowing the ERTMS/ETCS on-board equipment to be interfaced with the on-board part of an existing National Train Control system. It allows smooth transitions from/to the National System and gives access to some ERTMS/ETCS on-board resources (e.g. DMI).
TSI	The Technical Specifications for Interoperability (TSIs) define the technical and operational standards which must be met by each subsystem or part of subsystem to meet the essential requirements and ensure the interoperability of the railway system of the European Union.

Term	Definition
TSI OPE	Operation and Traffic Management TSI. The Commission has published the latest version of the TSI OPE under the Implementing Regulation 2023/1693 (TSI OPE 2023). This amends the Implementing Regulation 2019/773 (TSI OPE 2019). Some elements and in particular its appendix A (ERTMS operational principles and rules) are subject to a transition period and may not be applicable until December 2025.
LOC&PAS TSI	Locomotives and Passengers TSI as published in the Commission Regulation (EU) No 1302/2014 of 18 November 2014 up to its latest amendment by Commission Implementing Regulation (EU) 2023/1694 of 10 August 2023.

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Have your say

What to submit

Submissions are invited, responding to the various questions and topics raised throughout this document.

Responses are particularly encouraged from:

- Rail Infrastructure Managers, especially those that manage part of the NNI.
- Rolling Stock Operators, especially those that operate on the NNI.
- DTCT equipment suppliers.
- Delivery organisations involved in past and current DTCT initiatives.
- Governments / Infrastructure Authorities, especially those that set strategies for investment on networks forming part of the NNI.
- Unions.

When to submit

We are seeking submissions on this discussion paper by Thursday 17 July 2025.

How to submit

Any organisation or individual can make a submission to the NTC.

Making your submission

 Email your submission to NRAP-Secretariat@ntc.gov.au

Where possible, you should provide evidence, such as data and documents, to support the views in your submission.