



Rail Technical Strategy

Innovating across Britain's railway

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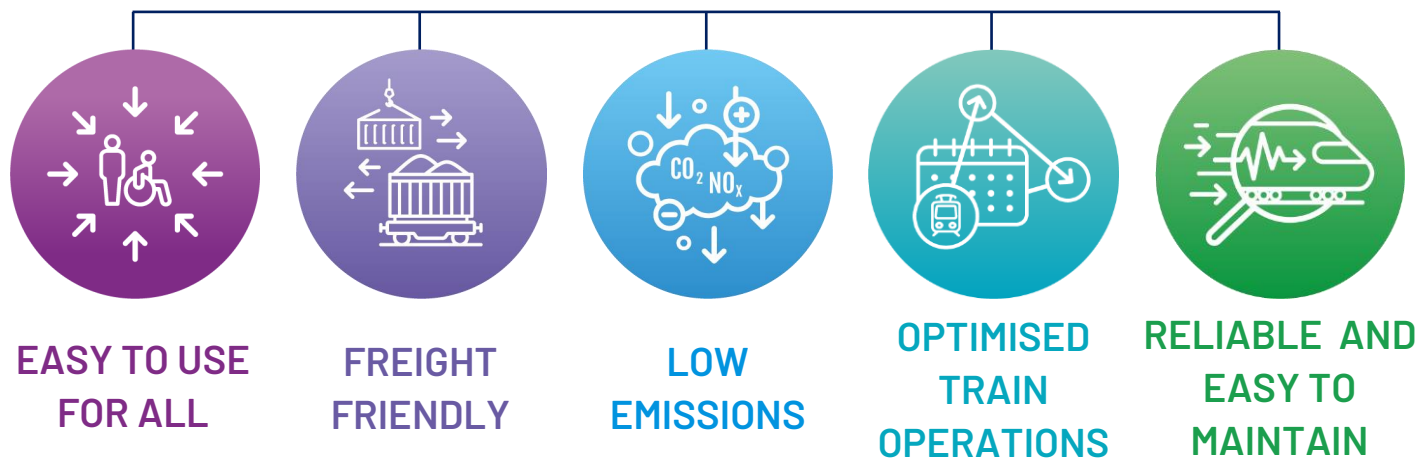


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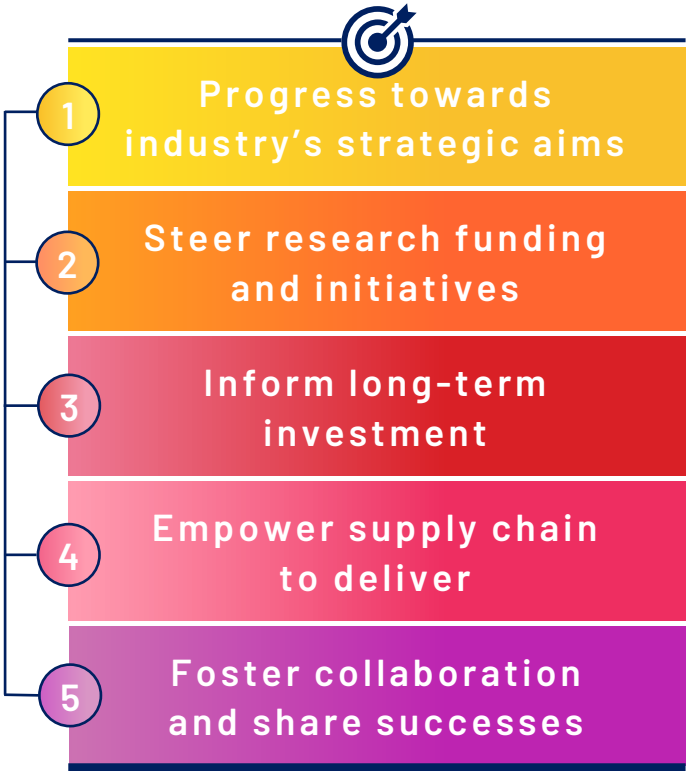
FUNCTIONAL PRIORITIES



CRITICAL ENABLERS



DESIRED OUTCOMES



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FOREWORD

The Rail Technical Strategy has been a major shift for the industry. It outlines how we are making a step change in innovation across the rail sector and provides us with a springboard to address long-standing challenges that the rail industry has faced.

I am pleased to support the refreshed strategy, which continues to provide us with opportunities to collaborate and build long-term solutions in areas such as environmental sustainability, affordability, reliability, and safety.

Rail reform will deliver closer integration between track and train, offering innovative ways of working that will optimise whole system performance, providing greater value for passengers, freight customers and taxpayers. Network Rail is committed to working with our industry partners to deliver the vision and goals of the Rail Technical Strategy.

Our investment in new technology is designed to help our knowledgeable and passionate colleagues deliver a railway fit for the future. We're enabling our teams to carry out their roles in safer environments by fitting inspection systems to trains and aerial drones. By applying new inspection capability we're enhancing our knowledge of asset performance and risk, moving us closer to 'right asset, right intervention, right time' management of our infrastructure. We're investing in new infrastructure designs to respond to the challenges of net zero, and weather and climate resilience. We're collaborating across industry to unlock and drive growth in freight traffic in support of wider government climate and economic growth targets. And longer term we're investing in technologies such as quantum, automation and AI that will allow us to continue to become a more efficient, safer, and better performing railway.

Collaboration is at the heart of this strategy which couldn't have been developed in isolation. We can only succeed when we work as one rail industry. Let's embrace this refreshed strategy, reset our expectations to harness technology and work together to deliver long term solutions.



Andrew Haines

Andrew Haines

Chief Executive, Network Rail

Rail Technical Strategy

Innovating across Britain's railway



FOREWORD

There is a broad consensus about key elements of reform needed for the railway including the need for a new guiding mind to establish an overarching strategy which enables consistent and joined-up plans for the whole railway. The Rail Technical Strategy will help to underpin that overarching strategy by aligning with desired outcomes and providing a clear steer to all those involved about the key areas where collaboration and innovation are most needed.

The RTS has evolved over nearly two decades. We've seen it become increasingly "owned" by industry as an enabler for change. The broad approach has been consistent and each evolution has built on strengths while also making improvements or adapting to the changing environment. Covid has accelerated changes in travel patterns and changed our perspective on safety. The importance of freight was always implicit but being more explicit about this will help enable a customer-focused and freight-friendly railway. The need for improved efficiency has also been ever-present but giving this more direct emphasis will also be helpful. The urgent need for climate action and growing inequality makes it ever more critical for rail to play its part in enabling as well as adapting to environmental and social change.

I've been pleased to be able to support the evolution of the RTS from my previous positions in industry and now from academia. The UK Rail Research and Innovation Network (UKRRIN) was designed to create powerful collaboration between academia and industry to provide a step change in innovation and accelerate new technologies to market. As such it illustrates the sort of collaboration that will be needed to respond to challenges and opportunities set out in the RTS.



Professor Paul Plummer

Director, University of Birmingham Centre for Rail Research and Education (BCRRE) and lead for UK Rail Research and Innovation Network (UKRRIN).

Rail Technical Strategy

Innovating across Britain's railway



FOREWORD

The UK created the railways two centuries ago. Over that time, the UK rail industry has been at the forefront of innovation, delivering new technologies which have improved both connectivity and mobility for both passengers and freight for the benefit of the economy and society both nationally and regionally.

A positive outlook lies ahead for the global rail market with European rail supplier body UNIFE forecasting growth of 3% a year until the end of the decade fuelled by the prospect of 10,000 future rail project orders including greenfield investments, replacements and modernisation projects.

What's more, key global macroeconomic trends such as urbanisation, digitalisation and sustainability are driving demand for transport which, in turn, enhances the competitiveness of rail not least because of its low carbon credentials.

UK suppliers are well placed to capitalise on this upward trajectory given the growth in the export of rail-related goods and services across the world in recent years particularly in regions such as the Middle East and Australia. That reflects positively on the strength and depth of the UK's domestic market as well as the future potential for leveraging this internationally.

This Rail Technical Strategy provides a strong foundation for achieving these objectives. For the UK rail supply community, the Strategy provides a clear steer for our future direction. Alongside the UK Rail Research and Innovation Network, Network Rail's R&D Portfolio, the work of HS2 and TfL and organisations like RDG and RSSB, the Rail Technical Strategy can help support suppliers in delivering innovative new products and services and producing more value from the UK's £40 billion plus railway industry. I would urge all, whatever the size or discipline of your organisation, to engage with this important work.

Significant challenges, of course, lie ahead for the industry but UK rail is well-placed and ready to meet them. What's more, the opportunities from the Strategy are also considerable – a rail sector that is able to meet these challenges through innovation will not only provide greater benefits to rail users, it will be able to use these new technologies to export more around the globe, generate more investment and jobs, and attract even more talented individuals to join the sector.

And the UK will maintain its longstanding tradition of a cutting-edge, world-leading rail industry, building on our historic railway heritage.

Darren Caplan

Chief Executive, Railway Industry Association

October 2024

Rail Technical Strategy

Innovating across Britain's railway



FOREWORD

I'm delighted to endorse this refresh of the Rail Technical Strategy (RTS). This practical yet ambitious strategy sets out a path to a sustainable, efficient, and even safer future. By gaining industry agreement on the technical opportunities to drive progress against these priorities, the RTS complements the Sustainable Rail Blueprint and the recently updated Rail Health and Safety Strategy.



Mark Phillips

Since its 2020 release, the RTS has been a living strategy that reflects the latest initiatives to help organisations coordinate their technical developments. This full refresh, including a greater focus on freight, was needed to keep it relevant and valuable. I'm proud of RSSB's leading role in engaging right across the industry to make this happen.

RTS helps steer RSSB Research Programme towards agreed areas, confident that industry will see its value and take up the findings. It also fosters collaboration, providing a channel through which we can understand what technical developments other organisations are working on. This helps coordination and avoids duplication.

Standards – a major part of RSSB's role – are essential to technical development. Innovations often need a framework for safe and efficient adoption, which good standards provide. RSSB will continue to work with industry to create the evidence-based standards required to achieve the RTS goals.

RSSB's world-leading expertise in safety and risk is again essential in progressing towards the RTS vision. The introduction of new technical solutions needs to be underpinned by a sound understanding of how they affect overall risk. This is essential to successful innovation. And this is why we are working on further enhancing our risk modelling capabilities.

The RTS matters to everyone. Delivering against the technical challenges and opportunities it sets out will be good for passengers, freight customers, and the nation. I know that your energy and commitment will help to make it real.

Mark Phillips

Chief Executive office, RSSB

About the RTS



Why do we need a Rail Technical Strategy?

The RTS sets a clear direction for the development and uptake of existing and new solutions that are essential for industry to deliver against the challenges it faces.

Since the 2012 version, the RTS has been valuable in aligning thinking and action in the UK and more widely, globally promoting the UK's world-class rail expertise and its vibrant innovation community.

The direction set in the RTS is key to informing the investment pipeline within industry organisations. Senior budget holders in infrastructure managers, vehicle owners, train and freight operators and OEMs have better visibility of the direction of travel when it comes to the technical needs and opportunities that the railway has. This in turn is essential to ensure that supply chain is stimulated to invest with confidence in innovative solutions in the most important areas.

The RTS is also important to guide the prioritisation of existing dedicated research and innovation funds that the railway has and facilitate their coordination, including the establishment of easy pathways for progression through the Rail Industry Readiness Levels. It also allows the rail industry to influence and make the best of the R&D spending that exists beyond rail and the transport sector, which could have applicability to the challenges rail faces.

Why is a new edition needed?

Many longstanding challenges for rail in the UK remain and new challenges continue to emerge, especially in light of the Covid-19 global pandemic and its aftermath. In order to reinvigorate interest and achieve greater buy-in for rapid and coordinated technical progress, this edition has been developed with the following principles in mind:



More focused, with clarity on the agreed key problems, opportunities and solutions that need industry attention, rather than attempting to create a fully comprehensive plan



More compelling, in particular, setting out the steps needed in the short term, in the context of the longer-term vision



Less R&D centric, acknowledging that research and development is only part of any successful technical strategy, and therefore putting equal emphasis on the challenges and opportunity around successful deployment and adoption

This digital edition is a living strategy which, thanks to ongoing contributions from across the industry, becomes richer over time, captures progress, and evolves to support industry long term strategy.

About the RTS



RTS Lead Authors

This edition of the RTS was authored by a core working group comprising representatives from RSSB, Network Rail, both academic and industrial UKRRIN partners, the Rail Delivery Group and Great British Railway Transition Team.



Rail Delivery Group



Governance and other key contributors

The strategy was developed collaboratively with key input and review provided by the Rail Industry Association, Rail Freight Group and Rail Partners.

Steering has been provided by the Executive Technology Leadership Group who will continue to sponsor and promote delivery of the strategy.



Review, support and engagement

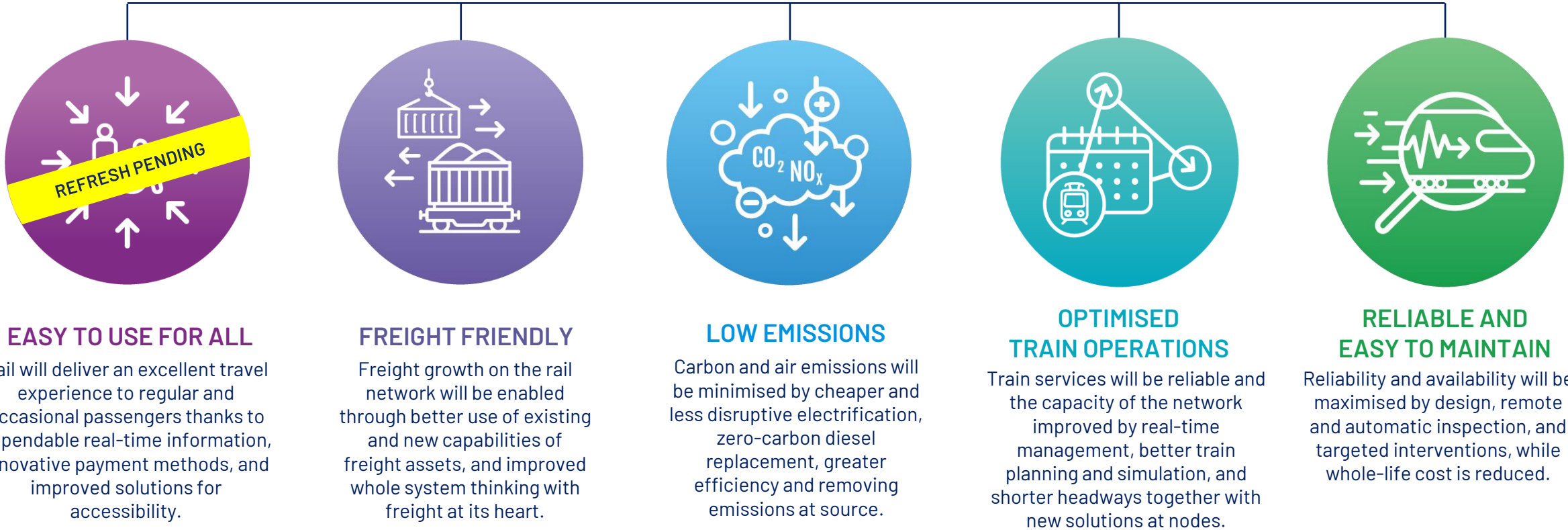
Over 100 organisations and more than 30 prominent cross-industry groups have engaged with the development of the new and refreshed functional priorities.

Anyone in the rail industry is welcome to contribute to its ongoing development.

You can get in touch with the RTS Engine Room at rts@rssb.co.uk

FUNCTIONAL PRIORITIES

The five functional priorities are industry agreed focus areas where rapid progress is needed and new technical solutions are critical. For each priority, explore the key goals and the 'routemap' that highlights the steps needed in the next five years to get to a sound position in 2025 and set the essential groundwork for progression towards the 2040 vision.





Easy to use for all

Rail Technical Strategy



Rail will deliver an excellent travel experience to regular and occasional passengers thanks to dependable real-time information, innovative payment methods, and improved solutions for accessibility.

Improving the overall experience and accessibility is essential to make rail the mode of choice for a much broader range of journeys and playing an important part in enabling a more inclusive society.

Key goals

- Accurate, accessible and understandable real-time information
- Smart fare collection
- Personalised services
- Accessible to all
- Door-to-door solutions
- Reliable and fast on-board connectivity



Anthony Smith
Chief Executive
Transport Focus

“New knowledge and technical solutions have a key role to play in making the railway passenger centric and easy to use. It is crucial that the rail industry puts passengers’ needs and expectations at its heart.”



Easy to use for all



Anthony Smith
Chief Executive
Transport Focus

While navigating the railway not without its challenges, for the majority of regular passengers navigating the railway is relatively easy. Most commuters are familiar with their journey from the point of ticket purchase, to the platform they need to wait on, and they know where to stand on the platform to maximise their chances of finding a seat. By contrast, occasional rail users who lack experience, may not feel confident travelling by rail.

Getting in a car and travelling directly to their destination is the preferred option for many. It involves less planning, is perceived to be cheaper and more reliable than rail, and it guarantees a seat in an enclosed environment, with a secure place to store luggage. At present, due to the coronavirus pandemic many people are avoiding crowded places and opting for alternative modes of travel to public transport. Transport Focus research into future travel plans shows that while the use of public transport has increased since the start of the pandemic, almost half of respondents say they intend to drive more, where they would have previously used public transport. In addition, half of those who had not made a train journey in the previous seven days, stated they would not feel safe doing so.

The number of people commuting or making long-distance business trips is widely predicted to decline in the longer term. The recent practice of working from home and holding virtual meetings has led many commuter and business travellers to question whether they will need to travel to the same extent in the future. Now, more than ever, the railway needs to prioritise making itself easy to use. It needs to appeal to passengers.

I am pleased to see that the new Rail Technical Strategy puts passengers at its core, an encouraging departure from previous editions that brings a fresh perspective and focus to the strategy. New knowledge and technical solutions have a key role to play in making the railway passenger centric and easy to use. It is crucial that the rail industry puts passengers' needs and expectations at its heart.

Existing solutions must be harnessed to provide seamless end-to-end journeys. From accelerating the adoption of step-free inclusive design, to the 'Internet of Trains' and Big Data to improve punctuality. Reliability and accuracy of information is essential.

This must go together with the rapid roll-out of innovations already under development, such as the Digital Fares and Ticketing Platform, to improve the service offered to passengers. This includes multi-modal ticketing, new solutions to remove hazards and barriers for disabled passengers and infection prevention and control measures. Minimising the spread of infection has an important role to play in public transport and even more so as a result of the Coronavirus pandemic. A greater understanding of virus management can both reassure passengers and inform industry strategy.

Longer term opportunities and solutions must not be forgotten. Data-driven tools to understand and improve passenger flow within and across modes, and innovative designs to improve the onboard experience have the potential to deliver important benefits at limited cost.

This all needs to be underpinned with passenger centric measures of the railway's overall performance. New measures are needed to incentivise rapid, incremental improvements and drive longer-term changes in mobility. Measures to move the industry towards its key priority of providing passengers with timely, easy to use and reliable door-to-door mobility services.



Easy to use for all

***REFRESH PENDING**

RTS Innovating across
Britain's railway

GOALS	WHY?	STATUS IN 2020	STEPPING STONES OVER THE NEXT 5 TO 8 YEARS			VISION FOR 2040
Accurate, accessible and understandable real-time information	Making it easier for passengers to plan and manage their journey reduces stress, exclusion and time lost, and increases confidence.	Real-time information is available but not always reliable and useful. Also staff on the ground often don't have the same information. New need for information relating to biosecurity in rail environments.	Improvements in the timeliness, reliability and accuracy of the information needed for door-to-door travelling, including information on layout and current status of facilities of stations and trains.	Personalised information sent to customers based on their journey and travelling patterns. Development of biosafety indicators that support customers and industry decisions.	The availability of data enables new services from the wider market that cover door-to-door needs. These include information interface for mobile devices, hearing aids and station navigation tools.	Timely, easy to use and reliable door-to-door information with rail at its heart.
Smart fare collection	For rail to be attractive it is key that passengers can easily buy rail as part of their travelling options and door-to-door journey.	Ticketing is complex and offers limited flexibility. Lack of clarity on best price available. Limited cross-modal payment options, mainly in urban areas and for train-bus combinations.	Rail pay as you go to cover frequent, shorter and cheaper journeys (including city, regional and intra-regional). Account-based ticketing underpins the Digital Fares and Ticketing Platform to allow simplification and personalisation.	Smart ticketing on mobile devices to improve reservation and personalisation for less frequent, longer, more expensive journeys. Digital Fares and Ticketing Platform enables richer services to passengers and third parties.	Open data and suitable commercial agreements deliver multi-modal ticketing provision.	Buying door-to-door journeys, either in advance bookings mode or 'get up and go' is the norm, and rail always appears as an option when appropriate.
Personalised services	Personalised services and assistance, where requested, make travelling by rail an easy and more enjoyable experience.	Minimal customisation and personalisation of train services. Limited availability and use of individual customer's data and their journeys to improve experience.	The underpinning customer data to provide personalised services is developed and customers are keen to share their data because its use is fair and clear and there are benefits to them.		Open data and AI enhance the level of customisation of support and services.	The level of customised support, convenience and inclusivity delivered by rail improves the travel experience for all and rivals other modes.
Accessible to all	Reducing exclusionary barriers throughout the railway enable more people to travel, and to travel independently.	Focus is mainly on step-free access to stations and platforms with limited initiatives for other capability impairments.	(Specific) real-time passenger feedback is proactively sought and made easy to provide.	Passenger centric measures of rail performance are identified and used.	New design solutions on trains make on-board tasks and activities easier and more pleasant.	
			Deployment plan and guidance to speed up the adoption of existing step-free solutions (e.g. humps and low-floor trains).	Assess new solutions to remove hazards and barriers for people with reduced mobility (e.g. gateless access and crowding control).		
			Roll out tools for people with less visible disabilities to use the railway.	Account-based digital services make booking and providing assistance easier.		
Door-to-door solutions	In a fast-changing transport landscape it is key to make it more convenient and less stressful for customers to use rail as part of their multi-modal journey.	Websites to plan and provide real-time support for door-to-door journeys exist but have significant limitations. Rail focuses on the delivery of train services, and customers are expected to sort out their first and last mile, with very limited services provided by rail to support their full journey.	Improve parking and connection facilities for existing modes (including electric vehicles) at stations.		Develop operational concepts and facilities for connections with emerging modes (including micro-mobility).	Railway plays a key role in the provision of door-to-door, not just point-to-point, transportation.
			Data exchange in place to allow better connection decisions by transport operators and the travelling public.		Feasibility studies on tools to optimise passenger flow within and across modes.	Information to and from passengers used to manage capacity and optimise its use.
Reliable and fast on-board connectivity	Customers expect to be always connected if they so choose.	Phone and mobile data coverage on trains is patchy and unreliable.	Lessons learnt from 5G trials inform technical and commercial plans.	Agreed overall plan to improve rail connectivity starts to be delivered.	Regular reports on the extent and quality of mobile coverage on the railways are in place.	Good on-board voice and data connectivity is a given when travelling by rail.



Freight friendly

Rail Technical Strategy



Freight growth on the rail network will be enabled through better use of existing and new capabilities of freight assets, and improved whole system thinking with freight at its heart.

Rail freight makes a major contribution to the UK economy, providing an efficient and green way of moving goods around the country and alleviating congestion on the roads. Rail freight is already contributing £2.45bn to the UK economy. Meeting the long-term rail freight growth target of at least 75% by 2050 will deliver even greater economic and environmental benefits.

Key goals

- Increased network access for freight
- Safer freight operations and better asset management
- Enable greater intermodality and access for freight customers
- Greater asset utilisation and reduced freight journey times
- Low carbon freight and on-track machines



Maggie Simpson
Director General
Rail Freight Group

“The opportunity for rail freight has never been greater, with customers looking to move more by rail to reduce their carbon footprints, and government setting ambitious targets for growth. The focus on freight in the 2024 update of the RTS is therefore both timely and welcome.”



Freight friendly



Maggie Simpson
Director General
Rail Freight Group

The new specific focus on freight within the Rail Technical Strategy (RTS) highlights the critical role that rail has in supporting the UK's supply chain network. Rail freight provides the most efficient, safe, and green way of transporting goods across the country, and its economic, environmental, and societal benefits are significant.

In 2023, the government announced a long-term rail freight growth target of at least 75% by 2050, providing confidence to those wanting to move goods by rail. Realising this and delivering a shift from road to rail will also support the government's 2050 net-zero policy. To drive this growth and to seize the opportunity before us, we need to address the challenges that the rail freight sector faces today.

Innovation is pivotal and will ensure we are advancing alongside other transport modes, to maintain and further enhance our competitiveness. We need to not only develop and improve what exists today, but embrace new ideas about wagons, terminals, and systems of the future. The goals and technical stepping stones identified in the RTS will open opportunities for Network Rail, Freight Operating Companies and End Users to do exactly this. And this is why I am delighted to be Sponsor for this RTS priority.

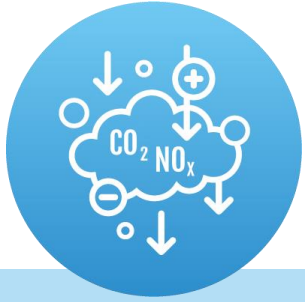
- So, what are some of these opportunities?
- Greater use of data, together with better and integrated systems, to allow for dynamic interrogation of the best options for moving goods from one point to another, reducing carbon and improving outcomes for customers.
- More dynamic and efficient paths to allow rail to compete effectively with road, and assets to be cycled more productively.
- New solutions to continue to digitise rail freight locomotives and wagons, enhancing safety, increasing reliability, and bringing cost savings.
- Better understanding of asset condition to ensuring timely interventions and minimal timetable disruption. This will become increasingly important with higher traffic volumes and increasing weather events, alongside the need to safeguard critical routes.
- Being innovative, dynamic and data driven in the service offering to attract those new to rail and break down the barriers they are experiencing.

Technology is critical to modernise, boost efficiencies, reduce costs, and further support an integrated supply chain. The rail freight sector needs to be on the front foot of this transformation. The direction and focus that this RTS priority gives to all freight stakeholders in working together towards a truly 'freight friendly' railway is essential to a successful transformation that makes rail the mode of choice for new and existing customers.



Freight friendly

GOALS	WHY?	STATUS IN 2024	STEPPING STONES OVER THE NEXT 5 TO 8 YEARS					VISION FOR 2040			
Increased network access for freight 1	The GB network is one of the most restrictive in the world due to its historic nature and legacy infrastructure. Easy and predictable access for heavier, longer, and larger freight trains is key to maintain and grow freight traffic. It also improves the efficiency of freight operations.	Current limits to freight train length, weight and size are based on empirical data. RSSB-led research recently developed a methodology to revise the limits that unlock longer train formations. These new limits are now being applied on the network on a case-by-case basis, in advance of systematic embedding in the NR Loads Book.	Develop a digitised platform to provide optimised route options for freight services based on train characteristics including length, weight and size, and infrastructure asset information.		Assess the case for targeted deployment of track design solutions to minimise the impact of freight traffic.			Compliant routes and pathing options for freight journeys are automatically determined and are responsive to freight needs. All key routes for Heavy Axle Weight traffic are maintained and do not require special dispensation access rights. The introduction of new locomotives, wagons, and wagon / box combinations is efficient and streamlined.			
			Improve industry visibility of current and future route availability for Heavy Axle Weight freight services to allow for better and more informed asset management.		Assess the business case for targeted interventions for gauge improvement to unlock route compatibility with maximum impact. Consider the holistic benefits to other service types (e.g. higher speeds for passenger trains).						
			Embed and exploit changes to W10 and W12 definitions that accommodate more wagon/box combinations over greater parts of the network.		Review business case and incentives to unlock innovation in rolling stock technology which reduces the impact on infrastructure, such as track wear and cyclic top.						
			Reduce effort required to complete vehicle compatibility process through improved data availability, systems and simulation tools.								
Safer freight operations and better asset management 2	Better monitoring of freight assets allows failure prediction and timely proactive intervention. This can significantly reduce unplanned maintenance and incidents on the network, including derailment risk.	Nearly all safety inspections and train preparation for freight are manual tasks. This introduces human error and, over the last 5 years, has led to a significant number of safety events, including some with significant consequences. Recent trials have demonstrated options for improving loco and wagon connectivity enabling greater automation of asset monitoring.	Assess options for power provision to wagons, accounting for network and off-network requirements. Such wagons to be electrically inert in sidings and yards.		Assess the feasibility of cameras, sensors and other technology in undertaking train safety checks within terminals, thus removing exposure to dangerous tasks.		Explore freight specific options and requirements for remote condition monitoring (RCM) solutions alongside wider industry RCM requirements. Assess the business case for tactical deployment.	Sudden asset failures and associated incidents on the network are regularly and successful prevented. Yards are significantly safer with workforce exposure to risk minimised.			
			Explore options for standardised RCM data protocol for locos and wagons, including how the data is transmitted, formatted and structured, and who has access to various components.		Obtain new insights from increased RCM data to improve the identification of precursors to failures and safety events and to produce better understanding of their root causes.						
			Develop an understanding of the root causes of increased instances of wagon wheel flats experienced on the network, and what can be done to prevent them.								
Enable greater intermodality and access for freight customers 3	Rail freight is perceived as a difficult mode to start using by new customers. Growth opportunities can also be challenging for existing customers.	Connections to the network are very costly, and currently take over a year to be approved and built. This deters prospective and existing customers to develop new flows.	Develop options for dynamic aggregation of goods to facilitate the movement of smaller individual quantities which respond to customer supply chain needs.			Develop industry systems to provide an easier understanding of how rail can serve their customers' logistics needs.		Existing and potential freight customers see rail as an attractive mode. Deployment of new connections to off-network locations is dynamic to customer demand and lower cost.			
			Explore growth opportunities using parts of the existing network by providing flexible and temporary loading sites, in addition to fixed terminal/yard infrastructure								
Greater asset utilisation and reduced freight journey times 4	Freight travels at lower average and maximum speeds than passenger services. This difference causes freight trains to be signalled into lineside loops or regulated at a junctions. Understanding the value of higher freight speeds and ways to increase these, is key to improving the attractiveness of rail and the utilisation of freight assets.	Due to the prioritisation of passenger services and allowed maximum speeds, the low average speed has negative time and cost consequences for freight journeys. It also significantly limits assets utilisation, ultimately reducing the commercial viability of rail freight and making it less competitive against road.	Identify opportunities for enhanced speed differentials on the network that fully accommodate the capability of the infrastructure.		Explore options for the safe application of higher maximum permissible speeds to increase capacity and unlock new paths through reduced block occupation times.		Increase capabilities of industry planning services systems (R2, TOPS) to provide the outputs required to realise the full capacity and pathing benefits offered by future ETCS roll-out.	Full use of technical capabilities of freight trains combined with mechanisms to recognise the value of freight journeys results in significantly reduced journey times, and easier and better freight pathing.			
			Agree and implement changes to the Network Code to support the deployment of freight friendly pathing that recognises the economic importance of freight services.		Incorporate modelling capabilities which analyse timetable and performance data to optimise pathing options and opportunities.						
			Evaluate options for self-powered wagons, including utilising regenerative braking technology, to improve acceleration capabilities that unlock new pathing options.  4,5		Develop path modelling capabilities that consider whole system impact and benefit to UK PLC, including economic and carbon impacts of rail freight.  4,5		Improve traffic management utilising C-DAS to enable better on-the-day regulation decisions that are underpinned by improved freight pathing algorithms.  4,5				
Low carbon freight and on-track machines 5	There is currently no viable alternative to electrification or (bio)diesel to deliver the power necessary for the full range of freight journeys on the GB network. Electric traction offers capacity and operational benefits over diesel. Without action, rail freight risks being less favoured than other modes as they continue to decarbonise. This could cause long-term congestion and economic disbenefit if a lower proportion of freight is moved by rail.	Industry is currently introducing bi-/tri-mode locomotives which are envisaged to deliver significant last-mile benefits and operational flexibility. But traction electricity charges and spikes in electricity prices can make it more cost-effective to haul using diesel. Industry is looking into maximising the benefits of future electrification for freight, including freight infill.	Learn lessons from battery and multi-mode trains operating on the GB network and internationally.		Assess freight power options based on the capabilities of the electrified network, plans for future traction energy, and freight-specific technology developments.		Explore optimised electrification designs and solutions for secondary freight-only routes.		Explore options for integrated charging facilities for both road and rail at terminals.	Assess low-cost electrification options at terminals.	There is a clear role and relevance for rail as part of an overall net-zero logistics chain.
			Explore the feasibility of intelligent/dynamic freight consist arrangements to reduce aerodynamic drag.		Assess actual performance of novel low-carbon fuels, and the feasibility and costs of associated engine changes.						



Low emissions

Rail Technical Strategy



Modal shift from road and air travel to rail, combined with actions to lower rail emissions, can make a substantial contribution to tackling climate change and air pollution. Rail emissions will be reduced by new – full and partial – efficient electrification, zero and low carbon vehicles, and a whole-system, whole-life approach to managing carbon.

Critically, the new goal of Intelligent Energy Management of traction power has an important role to play in helping getting the right amount of power to the right places, at the right time.

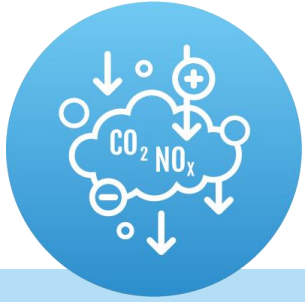
Key goals

- Efficient new electrification
- Zero carbon self-powered vehicles
- Low carbon freight and on-track machines
- Intelligent energy management
- Cleaner air
- Quieter railway
- Lowering embodied carbon of key material



Malcolm Brown
CEO, Angel Trains and
Chair of the Sustainable
Rail Executive

“The Low Emissions updated routemap offers greater depth of thinking on where and how technical development can unlock the changes required. Let’s continue to use it to make progress happen.”



Low emissions



Malcolm Brown
CEO, Angel Trains and
Chair of the Sustainable
Rail Executive

Rail is responsible for a small proportion of the large quantity of emissions which transport generates. This is why modal shift from road and air travel to rail, combined with actions to lower rail emissions, are so important. This combination can make a substantial contribution to tackling two of the most urgent and significant threats we face.

Since I endorsed the previous edition of the Rail Technical Strategy (RTS), concerted, joined-up efforts across the industry have allowed progress to be made. The introduction of battery-hybrid trains into regular passenger service by Transport for Wales, and the robust guidance based on RSSB research now available for operators to produce Air Quality Improvement Plans are two exemplars, showing what is possible with the right strategic stimulus.

In my role as Chair of the Sustainable Rail Executive, I am extremely pleased with the complementary value of the RTS and the Sustainable Rail Blueprint (SRB). The SRB provides a framework to drive the transformation agenda, while the RTS offers greater depth of thinking on where and how technical development can unlock the change required.

The Low Emissions functional priority in this refreshed RTS builds on the 2020 one, but critically introduces the concept of Intelligent Energy Management. As rail consumption of electric power increases, the need to balance supply and demand becomes ever more critical and challenging. Traction power remains the major and most bespoke component of rail's electricity demand. In this context, intelligent management of traction power has an important role to play in helping both rail and the grid getting the right amount of power to the right places, at the right time.

The seven renewed key goals in the Low Emissions routemap include one in common with the new Freight Friendly priority. This 'shared' goal recognises the urgency to decarbonise the rail freight sector. And it is great to see how the other goals in the Freight Friendly priority are all geared toward freight growth and modal shift which is key for low emissions logistics.

Let's work together to ensure we stride smoothly, safely and rapidly across the stepping stones to the strategic visions for Low Emissions.



Low emissions

GOALS	WHY?	STATUS IN 2024	STEPPING STONES OVER THE NEXT 5 TO 8 YEARS							VISION FOR 2040
<div>Efficient new electrification</div> <div>1</div>	<p>Combined with modal shift, further electrification of the rail network is a fundamental step towards achieving the UK's 2050 net-zero target.</p> <p>Future electrification – whether full or partial – must be affordable, deliver operational resilience, and cater for smart interactions with trains.</p>	<p>Full electrification is recognised as the optimum choice for high-speed, high-intensity routes. Partial electrification, combined with multi-mode trains, is a viable contender on other routes.</p> <p>A range of solutions, including voltage control clearances, insulated pantograph horns, and increased span lengths, have started to address the cost and disruption challenge associated with new electrification.</p>	<p>Develop an updated and agreed plan of the end-state traction choices on different parts of the network. 1,2,3,4,5</p> <p>Learn lessons from battery and multi-mode trains operating on the GB network and internationally. 1,2,3,4,5</p> <p>Improve understanding of power regulation and max power draw requirements to make the most of existing electrification and reduce overall energy consumption. 1,2,3,4</p> <p>Develop and demonstrate options for smart management of power supply and demand during train planning and real-time operations with the aim to accommodate the maximum number of electrically powered journeys within the capability of the power supply. 1,2,3,4 Optimised train operations</p>	Embed adoption of the cost-efficient electrification solutions in all new electrification projects to reduce the cost and embedded carbon content.		Continue to develop cost-efficient electrification optimised to the GB railway gauge.	Revisit lower sector gauge to be able to implement the Merseyrail type conductor rail shroud on Southern region in the longer term.	Review electrification assurance and authorisation process to improve efficiency and efficacy.		Progress towards a net-zero railway by 2050 is well underway. 1,2,3,4,7
<div>Zero carbon self-powered vehicles</div> <div>2</div>	<p>Battery and multi-mode operations can deliver the requirements of passenger trains on lower-speed, lower intensity routes.</p> <p>As batteries and the associated charging infrastructure continue to improve, there is an opportunity to make the most of these developments.</p>	<p>Train manufactures have continued to improve the capabilities of battery and multi-mode vehicles. Initial deployments have happened in GB and several other countries.</p> <p>The procurement of further multi-mode fleets for the GB network has commenced but uncertainties remain, such as around whole-life costs, battery longevity, and ability to charge off existing electrification.</p>		<p>Agree whole-life costing and carbon framework to support capital investment decisions on possible different mixes of track and train traction choices on branch lines. 1,2,3</p>	Document lessons learned from Scotland, Core Valley Lines, Midland Main Line and TransPennine electrification schemes.		Develop and trial options for alternative power supply technologies / configurations on secondary lines (for example, Scott Transformers, Mini-SFCs). 1,2,3,4		All high-speed, high-intensity lines are electrified with high capacity, energy efficient systems that represent value for money.	
Develop technical standards and commercial guidance, informed by whole-system considerations, to support the procurement and introduction of self-powered and multi-mode vehicles, and supporting infrastructure.		Agree technical and operational options for partial electrification to make best use of rolling stock and infrastructure capabilities, including charging opportunities for battery trains. 1,2,3,4			Battery and multi-mode trains, supported by partial electrification, operate successfully and efficiently on the network.					
Develop and agree operational control options to enable the reliable running and charging of battery trains. 2,3,4		Investigate solutions to de-risk and speed up transitions between traction modes, including carrying out a review of bi-mode changeover process to avoid manual interventions and make automatic solutions quicker. 2,3								
<div>Low carbon freight and on-track machines</div> <div>3</div>	<p>There is currently no viable alternative to electrification or (bio)diesel to deliver the power necessary for the full range of freight journeys on the GB network. Electric traction offers capacity and operational benefits over diesel.</p> <p>Without action, rail freight risks being less favoured than other modes as they continue to decarbonise. This could cause long-term congestion and economic disbenefit if a lower proportion of freight is moved by rail.</p>	<p>Industry is currently introducing bi-/tri-mode locomotives which are envisaged to deliver significant last-mile benefits and operational flexibility.</p> <p>But traction electricity charges and spikes in electricity prices can make it more cost-effective to haul using diesel.</p> <p>Industry is looking into maximising the benefits of future electrification for freight, including freight infill.</p>			Assess freight power options based on the capabilities of the electrified network, plans for future traction energy, and freight-specific technology developments.	Evaluate options for self-powered wagons, including utilising regenerative braking technology, to improve acceleration capabilities that unlock new pathing options.	Develop path modelling capabilities that consider whole-system impact and benefit to UK PLC, including economic and carbon impacts of rail freight.	Improve traffic management utilising C-DAS to enable better on-the-day regulation decisions that are underpinned by improved freight pathing algorithms. 2,3,4	There is a clear role and relevance for rail as part of an overall net-zero logistics chain.	
					Assess actual performance of novel low-carbon fuels, and the feasibility and costs of associated engine changes.	Explore the feasibility of intelligent / dynamic freight consist arrangements to reduce aerodynamic drag.	Explore optimised electrification designs and solutions for secondary freight-only routes.	Explore options for integrated charging facilities for both road and rail at terminals.		Assess low-cost electrification options at terminals.
<div>Intelligent energy management</div> <div>4</div>	<p>Existing electrified lines face an increasing demand for power from electric and multi-mode services.</p> <p>Better understanding of real-time power demand and capacity, coupled with a strategy for alleviating constraints and reducing energy losses, is crucial to a low-emission railway.</p>	<p>Numerous areas have declared power supply constraints, and more are anticipated in the next Control Period.</p> <p>The development of the whole-system thinking required to improve the management of power supply and demand has started but is still in its infancy.</p>		Assess the technical and economic viability of using lineside energy banks to complement traction power supply.	Further assess and pilot the technical and economic viability of using lineside renewables to complement traction power supply.		Develop a range of options to remove / alleviate existing energy supply constraints on main lines. 1,3,4		Network traction power constraints are actively managed, with plans in place to remediate.	
			Improve measurement of energy consumption of trains, including energy quality experienced by trains running under the wires.	Develop mechanisms to bring together consumption data to have a better whole-system view.		Explore costed options to reduce losses on the DC network.		Traction energy consumption is minimised. Demand for electrical power is managed dynamically to make the most of available capacity.		
<div>Cleaner air</div> <div>5</div>	<p>Air quality is the most pressing environmental health risk in the UK, generating the urgent need to mitigate harmful pollutants from rail.</p>	<p>The understanding of the scale and location of air pollution on the network has increased, with some mitigations being trialled.</p>	Establish the air-quality benefits of hydrotreated vegetable oil and synthetic fuels.				Improve understanding of the impact of station ventilation solutions	Consider vulnerabilities and potential improvements of HVAC systems on trains.	Air pollutants and noise from rail operations are minimised to protect the health and wellbeing of the workforce, customers, and local communities.	
			Review technologies to support train idling reduction initiatives.		Develop options and business case for retrofittable air quality mitigations, such as exhaust treatments.		Develop and trial solutions that alert level crossing users at the crossing itself.			
<div>Quieter railway</div> <div>6</div>	<p>The growth of housing in rail proximity, and demand for services to run for longer hours, make the noise pollution generated by rail increasingly unacceptable.</p>	<p>The underlying causes of noise relating to wheel squeal and engines are poorly understood, making prevention and mitigation challenging.</p>	Test and deploy affordable solutions to gain proactive awareness of noise hotspots and their evolution over time.						The embodied carbon of rail assets is well understood and continues to be driven down.	
			Improve understanding of noise generated by engines and explore auxiliary power solutions to minimise it.		Bring together noise and vehicle dynamics experts to understand and mitigate the causes of wheel-rail noise.					
<div>Lowering embodied carbon of key material</div> <div>7</div>	<p>Key materials, such as steel and concrete, which make up the fabric of the railway, have high levels of embodied carbon.</p> <p>As a significant purchaser, rail has a role to play in driving the reduction of embodied carbon.</p>	<p>Initiatives across the industry have started to look at the role rail can play as a significant buyer of concrete and steel.</p> <p>Alternative carbon-friendlier materials are being trialled for rail applications, but there is limited clarity on the required performance level.</p>	Identify best practice from other sectors on recycling and circular economies, including incentive mechanisms.	Investigate life-cycle of traction batteries, including possible second use in rail, to minimise environmental impact and maximise whole-life value. 2,3,7		Steel, concrete, quarry economy - improve carbon quantification for the whole lifecycle of these materials including definition of the most appropriate boundaries from different questions and analysis.				
			Develop emission benchmarks for specific assets to inform design targets.	Test low-carbon concrete alternatives against performance specifications.	Improve steel scrap cycle to enable and monitor an integrated scrap route that keeps good quality rail scraps in GB.	Learn lessons from the early deployment of existing composite solutions to inform further use and research needs.				



Optimised train operations

Rail Technical Strategy



Highly reliable train services and greater network capacity will be achieved through flexible and robust train planning and simpler and safer real-time operations. These are underpinned by a strategic approach to improving signalling and train capabilities.

Delivering a reliable railway able to recover safety and quickly when incidents and disruptions occur is key to retaining and attracting new passenger and freight customers. This is why 'improved recovery from incidents and disruptions' is one of the five goals.

Key goals

- Infrastructure and train capabilities to overcome capacity constraints
- Simpler and safer real-time operations and decisions
- Improved recovery from incidents and disruptions
- Reliable and flexible train planning
- More affordable solutions for rail



David Horne
Managing Director
LNER

"The Rail Technical Strategy is crucial to leveraging the technologies and innovations we need to deliver an efficient, reliable, and sustainable railway for our customers."



Optimised train operations



David Horne
Managing Director
LNER

The Rail Technical Strategy (RTS) provides a framework to steer and accelerate change in how the railway operates. It sets out clear goals and stepping stones to improve our services today and successfully adopt the technologies we need for future train operations.

Since the last iteration of the RTS, the railway landscape has changed considerably. The scaling back of some major infrastructure projects has brought the capacity challenge into sharp focus. Hence, the need to ensure reliable and flexible train planning that maximises the capacity available is as pressing as ever. And this goes hand in hand with the need to find ways to make best use of and future train and infrastructure capabilities.

Good, safe, and timely operational decisions on a busy mixed traffic network will increasingly rely on using all available information to keep customers moving. Trains and infrastructure are being fitted with systems that can improve the flow of information between staff, track and train. To deliver maximum value and simplify operations, the wider deployment of these systems needs to be co-ordinated.

It is essential to recognise the affordability challenge that the industry faces. So, an important test for any new solution, with its associated capital investment, should be about whether it helps to simplify operations. Another important test should be whether the solution has been driven by, and tested against a clear set of operational requirements.

Over the past 200 years, operation of the railway has continually evolved as new knowledge and technology has become available. Together with the other four priorities and the critical enablers, the refreshed Optimised Train Operations routemap will help channel effort and underpin delivery of the railway we need for our customers.



Optimised train operations

GOALS	WHY?	STATUS IN 2024	STEPPING STONES OVER THE NEXT 5 TO 8 YEARS							VISION FOR 2040		
Infrastructure and train capabilities to overcome capacity constraints 1	There is the need to cater for reliable high-frequency services on parts of the network where capacity is constrained either because of headway lengths or bottlenecks at nodes. In progressing the roll-out of digital signalling, there is an opportunity to extract early value from this investment.	ETCS is being implemented on the southern section of the East Coast Main Line and on the Transpennine Route Upgrade, with planned further expansion on the West Coast, Midlands, and Brighton Mainlines. New rolling stock is increasingly equipped to support in-cab signalling, and CP7 will see ETCS fitment across fleets ramping up. Nationwide deployment of the infrastructure supporting these advanced systems remains a long-term plan, therefore in many locations train capabilities won't be fully exploited for some time.	Plan the migration to Automatic Train Operation (Grade Of Automation 2) including accelerating the introduction of targeted aspects of automation in train operations to improve system reliability and capacity (for example by implementing ABD0, CSDE and C-DAS).							Capacity constraints have been overcome in effective and efficient ways.		
Simpler and safer real-time operations and decisions 2	A simpler-to-operate railway enables better and safer service delivery at lower cost. Short-term solutions to improve and support operational tasks and decisions exist. The migration to new solutions, including digital signalling, must not add complexity and risks, and must strive to deliver early benefits.	Traffic Management has been deployed on the Western Route to minimise service disruption, provide accurate passenger information, and enhance operational performance. The deployment of C-DAS has seen limited progress due to challenges around the complexity of integrating the various systems required for its operation. Technical solutions to enable more informed and / or automatic interventions have started to be explored; for example, in the space of speed control and AI-powered review of safety-critical communications.	Keep a watching brief on the development in Europe's Rail toward Automatic Train Operation (Grade Of Automation 4). Adopt improved methodology for train planning rules to exploit ETCS. 1,4 Agree Train Protection Strategy (including speed management) to improve safety and accelerate availability of operational solutions traditionally associated with digital signalling, such the ability for more granular speed restrictions. 1,2	Remain involved in the System Pillar of the Europe's Rail Joint Undertaking (EU-Rail) which is set to deliver a unified operational concept and a functional, safe and secure CCS system architecture. 1,2 Update the long-term deployment plan for ETCS. Develop a network model and a speed restriction management system to feed into digital and conventional signalling, therefore enabling cab-fitted speed management for class b trains, and into train planning systems. 1,2,4 Pursue proof of concept(s) of economically viable solutions that mitigate transition risk between ETCS-fitted areas and exploit ETCS-fitted rolling stock.	Undertake analysis at key bottlenecks to prioritise specific, targeted improvements to existing signalling designs to enable capacity enhancements. Establish clear adhesion braking targets and testing criteria for representative conditions. Develop a framework to inform the mix of existing adhesion mitigations to deliver against the targets, and determine whether and what new mitigations are needed. 1,2,4	Develop an implementation plan for enhanced train protection in light of the ETCS long-term deployment plan and outcomes of proof of concept(s).	Develop and deploy solutions to make full use of operational data to generate and share insights, feedback and learning opportunities for front-line staff (for example automated indicators for driver performance, automated review of safety critical communication). 2,3	Adopt standardised design and operational interfaces for signalling solutions (and transitions between signalling systems) to reduce complexity and the need for specialist / ad hoc training.	Agree a plan to roll out a system-wide compatible Traffic Management with standardised data formats and sharing arrangements, on which functionalities such as C-DAS, stock and crew management, and efficient energy management could be added incrementally. 1,2,3,4 Develop and implement an Operational Voice Comms Strategy for both primary and secondary communication to remove outdated technologies and be ready to adopt FRMCS. 1,2,3,5 Develop options for the migration to FRMCS in different parts of the network. 1,2,5			
											Develop and assess solutions to augment staff competency during, and in preparation for disruptions. Develop predictive modelling capabilities powered / strengthened by AI to inform near real-time service recovery interventions by Control.	
												Improve data and insights available to staff in Control rooms to better understand issues (such as loading data, or front-facing CCTV). Improve capability to rapidly and effectively introduce and step out of contingency plans to improve response to disruptive events. 2,3
Improved recovery from incidents and disruptions 3	The ability of staff in Control and on the ground to safely, effectively and quickly manage and recover from incidents and disruptive events is critical to limiting disruption to customers. This requires a combination of new technologies and changes in current processes.	Recovery from incidents and disruptions remains a challenge across the network. High-profile incidents have raised questions about how to improve operational decision making in these challenging circumstances. The Industry Train Service Recovery (ITSR) framework has been rolled out across control centres and provides a common approach to incident recovery within Control. Setting up degraded working procedures continues to take time and, once in place, these significantly reduce the throughput of trains.	Develop, test and introduce alternatives to the traditional approach to pilot working in degraded conditions so that this can be deployed faster and more effectively following an incident. Fully deploy and continue to improve data-driven, risk-based approaches to the introduction and removal of speed restrictions to minimise performance impact without compromising safety. 2,3	Improve data and insights available to staff in Control rooms to better understand issues (such as loading data, or front-facing CCTV). Improve capability to rapidly and effectively introduce and step out of contingency plans to improve response to disruptive events. 2,3	Improve and make greater use of decision-support tools and dynamic risk assessments to enable continuation of train movements and minimisation of service stoppages or restrictions.	Develop and assess solutions to augment staff competency during, and in preparation for disruptions. Develop predictive modelling capabilities powered / strengthened by AI to inform near real-time service recovery interventions by Control.						
							Reliable and flexible train planning 4	Timetabling plays an essential role in making the most of existing network capabilities and delivering a reliable railway. Having easier, agile and robust ways to change and add train paths allows greater responsiveness to changes in network availability, and in passenger and freight demand.	The timetable remains based on train planning rules (TPR) and contingency within them to deliver timetable resilience limits capacity, particularly at nodes. Demonstrators to make 'very short-term planning' processes less manual and more robust using a 'track section occupancy' approach have been developed. These techniques could also be used to achieve seamlessness between 'very short-term planning' and 'short-term planning', and be applied earlier in the planning cycle.	Establish clear and formal links between long and short-term asset planning (infrastructure and rolling stock) and timetabling to ensure the capacity needed is built and existing capacity is exploited. 1,4 Progress toward the adoption of the demonstrators created to deliver greater automation and shorten the timescales when adding / changing train paths at 'short' and 'very short' notice. 1,4 Review the need and rationale for the boundaries between 'short-term planning' and 'very short-term planning'.	Develop and demonstrate options for smart management of power supply and demand during train planning and real-time operations with the aim to accommodate the maximum number of electrically powered journeys within the capability of the power supply. 1,2,3,4 Low emissions Establish common reference data for train crew availability, to underpin increased integration between traffic management and stock and crew. 2,3,4	Improve insights on actual usage of allocated train paths and their associated value. Improve insights on actual usage of possessions.
More affordable solutions for lower-use lines 5	The long-term viability of lines with low traffic is at risk. Their future economic sustainability requires reducing capital and operational costs, while offering safe, reliable services.	Radio Electronic Token Block (RETB) has been enhanced on the Far North line to enhance asset reliability and functionality. New low-cost systems are being developed for light rail and lower-use lines.	Explore new solutions to extend the life of conventional signalling on branch lines. Establish sets of requirements for signalling solutions on lower-use lines which can drive down costs and deployment time.	Assess enhancements made to RETB in Scotland to understand the case for similar solutions on low-volume traffic routes, enabling the removal of conventional signalling. Explore solutions for co-existence of different types of rail vehicles and operations.	Keep a watching brief on the regional railway system demonstrator (Europe's rail FA6) to consider the insights generated in a timely fashion.							



Efficient and reliable assets

Rail Technical Strategy



Rail assets will be more reliable and have lower whole-life costs, thanks to right time insights, efficient maintenance, improved resilience to a changing climate, speedier introduction of innovations, and better management of obsolescence.

Both start and end of life are critical to asset reliability and value. This is why two new goals feature in this priority. One aims to speed up and derisk the introduction of assets, and the other aims to help tackle growing and changing obsolescence challenges.

Key goals

- “Right-time” actionable insights
- Efficient, effective and safe maintenance, including renewals and overhauls
- Improved resilience to climate change and extreme weather events
- Speed up and de-risk introduction of assets
- Proactive management of asset obsolescence for safe & efficient operations



Martin Jones
Chief Engineer
Network Rail

“The RTS sets out a plan for development and application of technology solutions that will help the thousands of passionate and dedicated people across our industry deliver a resilient railway, fit for the future, that exceeds the expectations of our customers.”



Clive Burrows
Group Engineering
Director
FirstGroup plc

“There are plenty of technologies that we can exploit to unlock more efficient and reliable service for our customers. The challenge is to pursue and deploy them with ingenuity to harness real value now and in the future. The RTS is essential to drive and help coordinate the efforts required from across the industry.”



Efficient and reliable assets



Martin Jones
Chief Engineer
Network Rail

I'm very pleased to co-sponsor this refreshed priority alongside Clive Burrows. As the rail industry reforms to deliver closer integration between infrastructure and rolling stock this presents a new opportunity to deploy innovative ways of working that optimise whole system performance, delivering greater value for passengers, freight customers and taxpayers.

Technology will help us achieve the dual aims of enhancing our understanding of infrastructure performance and risk and improving the working conditions of everyone building, inspecting and maintaining our fixed assets. Those people are critical to achieving the Rail Technical Strategy stepping stones. This needs to be a truly collaborative effort, with people from across our industry at the centre of creation, development and testing of new ideas.

We'll deliver more reliable railway infrastructure by enhancing our understanding of asset condition, the rate of change of condition and the root causes of degradation. The RTS embeds this principle by identifying clear milestones for the introduction of more effective monitoring and measurement technology, and for converting raw condition data into knowledge and insight to help us fine tune asset management processes towards the objective of 'right asset, right intervention, right time'.

Network Rail has championed the RTS since it was first published in 2007. As Chief Engineer I'm very pleased to be able to continue this support and commitment as the RTS is updated for 2024. It's one of the key foundations for cross-industry engagement and improvement, setting a common direction for our dynamic rail sector and providing a consistent reference point as we make critical investment decisions. I look forward to working with Clive, colleagues from our industry partners, and Network Rail's regions and routes to deliver the more efficient and reliable railway our customers expect.

October 2024



Clive Burrows
Group Engineering Director
FirstGroup plc

I'm very pleased to co-sponsor this refreshed priority alongside Martin Jones.

We both welcome the direction of travel towards greater 'vertical integration' with track and train coming closer together. This makes it easier to take a whole system approach when looking at how to best achieve our common objective of delivering for customers.

Closer integration between infrastructure and rolling stock, offers a clear opportunity to gather greater and better intelligence on both fixed and mobile assets using in-service trains – allowing for more timely intervention and a reduced need for dedicated monitoring/diagnostic services.

With this increased understanding of both the current state of our assets, and their anticipated degradation profile, we can optimise interventions – striving for approaches that are less intrusive, less disruptive and significantly more cost effective without compromising safety. Resulting in more predictable, reliable service provision and lowering the cost and carbon of operating the railway.

The pressures on the UK public finance will challenge the level of capital investment available to rail over the coming years. In this context, we need to make the most of the existing network – and this is where the efficient and reliable assets, and optimised train operations priorities come together.

From a rolling stock perspective, speeding up the introduction of new assets and improving the management of digital component, from obsolescence to cyber threats, are key. New technologies, such as synthetic testing environments, are important stepping stones captured in the RTS. In addition, the strategy identifies the core role of people's skills and passion to successfully drive change and innovation through the whole life cycle.

From the first iteration of the RTS in 2007, I am proud to have championed the strategy in a variety of roles. Currently, on behalf of the operator community, as chair of both the Sustainable Rail Leadership Group, and the Vehicle/ Train Control & Communications System Interface Committee, I look forward to working with Martin and industry colleagues to drive technical progress towards a more efficient and reliable railway.

October 2024



Efficient and reliable assets

GOALS	WHY?	STATUS IN 2024	STEPPING STONES OVER THE NEXT 5 TO 8 YEARS				VISION FOR 2040
"Right-time" actionable insights 1	<p>The timely availability of actionable insights on asset condition is key to service reliability and efficient maintenance interventions.</p> <p>Solutions to monitor assets continue to grow and improve. These offer great potential if full value can be extracted from affordable deployments.</p>	<p>Rolling stock data availability greatly varies by age of fleet. Increased insight is available for fixed linear assets, particularly thanks to in-service train-borne monitoring solutions. These are opening new opportunities for the future mix of monitoring solutions.</p> <p>Network Rail's Intelligent Infrastructure programme has provided a framework for greater data integration.</p> <p>The challenges of extracting actionable insights from these developments and using them to change established ways of working remain.</p>	<p>Review, prioritise and share with supply chain the current asset monitoring challenges.</p> <p>Establish efficient and effective frameworks for multi-party data capture, data storage, data sharing and integration, and post-processing insights. These need to cover data ownership, costs, and liabilities.</p> <p>For a wider range of assets, demonstrate the data quality that can be achieved from measurements taken from in-service trains when compared to calibrated sensors on the Network Rail infrastructure monitoring fleet. This needs to include consideration of level of fitment needed on in-service trains and the data requirements of end users</p> <p>Integrate right-time asset insights into maintenance cycles, continuing to move away from routine inspection and maintenance of both rolling stock and fixed assets. 1,2</p>	<p>Introduce technology to accurately and repeatably capture the location of new and existing assets, mapping this information to an updated single version of the truth network model for fixed infrastructure.</p> <p>Develop a cross-industry strategy for future investment and adoption of RCM solutions to inform Network Rail infrastructure monitoring fleet upgrade, make the most of in-service monitoring, and rationalise current and future solutions.</p>	<p>Develop the strategy and specification for in-service monitoring and diagnostic of ETCS systems.</p> <p>Explore introduction of edge computing on-board asset monitoring systems for real-time data processing and analysis. 1,2</p> <p>Improve KPIs for depots to inform investment decisions.</p> <p>Encourage use of tech to monitor health, fatigue and well-being of maintenance workers. This includes roll out of existing tech, and monitoring of emerging solutions.</p> <p>Develop robust cost frameworks for key asset types that enable comparison of the whole-life cost of different capital investment options as well as different maintenance and renewal options, including the cost of sustaining obsolete design vs pursuing upgrades. 2,3,5</p> <p>Analyse and re-define asset engineering standards for mitigating extreme weather events and improving climate change resilience, considering both technical and economic considerations.</p>	<p>Develop validation and assurance principles for AI-powered solutions designed to generate insights and support asset driven decisions. 1,2,3</p> <p>Develop a common asset and data ontology to enable data captured from different sources to be easily federated, including rules for capturing asset location at different levels of accuracy. This links to the need to define and gather information on network capabilities and constraints identified in the 'optimised train operations' priority. 1,2,3,4,5</p>	<p>The wealth of asset data captured, particularly from in-service trains, is easily accessible and used to generate valuable and actionable insights. This allows operational decisions and asset interventions that deliver a highly reliable and efficient railway.</p> <p>Rail maintenance has been revolutionised through the integration of cutting-edge technology, data-driven decision-making, and a culture of continuous improvement. This ensure high levels of safety, efficiency, and effectiveness for maintenance interventions.</p> <p>Rail assets and operations have improved their resilience to extreme weather events and continue to adapt to climate change in a targeted and risk-driven way.</p> <p>New assets and novel solutions are introduced easily, in a timely way, and robustly thanks to widespread use of digital environments and value-adding full scale physical testing.</p> <p>Systems successfully cater for components with varied lifespans to exploit rapidly changing digital capabilities and the economic and environmental benefits of longer-lifespan assets.</p>
Efficient, effective and safe maintenance, including renewals and overhauls 2	<p>Only by pursuing the best mix of short, medium and long-term interventions, can maintenance be truly efficient and effective.</p> <p>Increased automation could improve the safety and health of the workforce and, at the same time, increase the quality and consistency of the results.</p>	<p>Numerous initiatives to make maintenance safer and more efficient have been undertaken.</p> <p>Promising research on automated solutions, for example to repair linear assets, are navigating the challenges related to business case and cultural acceptability.</p>	<p>Continue the technical development and operationalisation of specific solutions such as Discrete Defect Repair, Panoptic Bridge Inspection, Tenanted Arch Inspection and Automated Tunnel Examination to inform the roadmap to wider adoption of autonomous maintenance technology.</p> <p>Develop a dedicated 'boots off ballast' strategy for fixed infrastructure inspection, maintenance and renewal.</p>	<p>Ensure updates to the Rulebook support the adoption of autonomous inspection and maintenance solutions to come such as the Network Rail Robotic Inspection & Maintenance Vehicle demonstrator.</p> <p>Develop standards on the communication, navigation and data transfer required to enable safe, reliable autonomous plant operation.</p> <p>Where lineside site working is still unavoidable, pilot and roll out a range of solutions to improve workforce safety and reduce exposure to occupational health hazards such as manual handling, slips trips and falls and exposure to noise, fumes, and dust.</p>			
Improved resilience to climate change and extreme weather events 3	<p>Extreme weather events have a significant negative impact on both the safety and reliability of the network.</p> <p>With climate change increasing the frequency of extreme events, there is a need to identify, prioritise, and deploy cost-effective responses and mitigations to increase the resilience of the network and its operations.</p>	<p>Extreme weather events, such as the 2022 heatwave and the prolonged rainfall in 2023, had significant safety and performance consequences. As a result, rail is in the process of improving forecasting capability and operational response to extreme rainfall. For extreme heat, engineering standards for track have been updated and new inspection capabilities developed.</p> <p>There are still significant knowledge and capability gaps to move from reactive to proactive interventions.</p>	<p>Improve algorithms to turn 'weather forecasts' (temperature, rainfall and wind) into 'rail forecasts'. These improved forecasts will allow for better 'early warnings' based on safety and reliability risk.</p> <p>Review operational rules relating to extreme weather.</p> <p>Include in the review of assets monitoring challenges, new and different needs driven by extreme weather events (e.g. rail thermal stress; drainage systems; ground saturation; air con system). This needs to consider how extreme weather would influence frequency and granularity of the data required. 1,3</p>	<p>Develop and improve tools to ensure that the operational response for extreme weather events is informed by right time asset conditions and robust 'rail forecasts'. 1,2</p> <p>Optimised Train Operations: 2,3</p> <p>Improve consistent recording and mapping of the impacts of extreme weather events on rail assets and operations.</p> <p>Develop a system view of priority interventions from regions, routes and operators, and a cost-benefit analysis framework to inform the selection of weather and climate resilience investment decisions. This should also consider other transport modes to deliver best 'value' for national and regional connectivity.</p>			
Speed up and de-risk introduction of assets 4	<p>Reducing the time and resources needed for the safe introduction of new assets could deliver important benefits.</p> <p>With the pace of improvement of digital environments, testing and validation can evolve to cut cost and time while also derisking the introduction of innovative solutions.</p>	<p>There is consensus from industry and supply chain that testing and validation requirements for new assets are not always clear and proportionate.</p> <p>The ability to gather data from full-scale accelerated trials remains limited, leading to long timescales for the testing, validation, and acceptance of novel products such as composite sleepers.</p> <p>Digital testing solutions are rapidly evolving and improving but there are no agreed criteria on how to assess their quality.</p>	<p>Enhance guidance and support on efficient and effective pathways to testing, validation and approval.</p> <p>Improve validation and assurance processes for digital testing tools (and associated synthetic environments) to enable greater and more informed use of these and more focussed and value-adding physical testing.</p> <p>Develop Minimum Viable Product of a synthetic environment to accelerate design, testing and validation of ETCS renewals and support their transition into BAU (part of Network Rail T190). Use lessons from this to inform the development of synthetic environments to accelerate design, testing and validation of other asset types.</p>	<p>Review challenges and opportunities with testing, validation and acceptance of specific asset groups, leading to the production of helpful guidance.</p> <p>Ensure operational scenarios, use cases, and testing parameters are clearly defined from the outset and drive validation and assurance.</p>	<p>Improve availability of asset data that is representative of different parts of the GB rail network to feed into digital testing tools.</p> <p>Explore commercial models and technical enablers for testing data to be made more widely available.</p>		
Proactive management of asset obsolescence for safe & efficient operations 5	<p>In the context of increased use of digital technology and financial constraints on renewals, the challenges of obsolescence management have changed and increased, requiring a more robust and informed approach.</p>	<p>The industry is still experiencing a tactical response to product obsolescence which is not well co-ordinated across organisations facing similar challenges.</p> <p>Pressures on renewal investments increase the need to keep assets in operation for longer.</p>	<p>Achieve increased modularity in components for faster and easier maintainability and replacement, for example for capacitors and semiconductors.</p> <p>Repair and maintain Solid State Interlocking components to extend asset life, including the creation of a database of units to understand availability.</p> <p>Develop set of requirements to easily address compatibility, upgrading, and replacement issues of digital components (hardware and software) in all new assets.</p>	<p>Investigate commercial approaches to enable a viable and affordable supply chain for legacy components and systems.</p> <p>Improve information sharing to enhance prevention and dynamically respond to cyber security threats.</p>	<p>Develop skills in parallel with new solutions and ensure competency management caters for legacy assets. 4,5</p>		



DATA DRIVEN

Good exploitation of data underpins all the other priorities of the Rail Technical Strategy. It is the key enabler to many of the important and necessary goals that the future railway needs to achieve.

IMPROVED IMPLEMENTATION PATHWAYS

Collaborative research and innovation with a strong industry pull, drives and de-risks take-up, leading to reliable and timely deployment of novel solutions. Effective alignment with insertion points have a key role to play in ensuring the benefits are maximised. The critical roles that people and culture play are recognised.

DIGITALLY TALENTED WORKFORCE

Attracting and developing a vibrant and more diverse workforce is critical. The fast-paced developments of digital technologies pose a further attraction, retention and upskilling challenge. The railway continues to need people from a vast array of technical backgrounds and this increasingly needs to be underpinned by strong digital skills to successfully drive change and innovation.

CRITICAL ENABLERS

Making it a success goes beyond technical solutions

The technical success of the railway and our ability to make technologies deliver for our existing and future customers, depends on how we work together. Bringing about business driven innovation, findings ways to accelerate successful take up of new technologies, and ensuring that the rail sector attracts and develops ample digital talent.



DATA DRIVEN



Good exploitation of data underpins all the other priorities of the Rail Technical Strategy. It is the key enabler to many of the important and necessary goals that the future railway needs to achieve.

What is in place now

- A new national data-sharing mechanism has been delivered, via the Rail Data Marketplace (RDM). The RDM enables data owners to publish data products and set their conditions of use, including cost.
- A new cross-industry Standards Committee, focussed on operational data, systems and telematics has been established by RSSB.
- A number of new industry data strategies have been published or are in progress, including the DfT Transport Data Strategy and GBR TT's Data Strategy.
- DfT have published a Transport Digital Twin Vision and Roadmap, towards connected digital twins across four key areas: strategy and innovation; enabling environment; people, skills and culture; and technology and data. A Community of Practice group has been established to progress work in the Roadmap.

What we are working on

- Development of proposal(s) for a Data Interoperability Framework, to enable the identification of key data sources for sharing, and development of the strategy for making data available in open and standardised digital formats.
- Consideration of principles for federation of data systems and models and exploration of options for development with industry stakeholders.
- Development of a suite of projects focussed on improving data exploitation for the purposes of future risk modelling capability.
- Development and agreement of standards for priority pipeline of data sources.

Where we need to get to

- Data is treated as a critical asset.
- Opportunities are sought for its exploitation, including the development of new technological capabilities that support the achievement of key desired outcomes.
- Data is underpinned by fit-for-purpose governance, systems, tools and technical skills.



IMPROVED IMPLEMENTATION PATHWAYS



Collaborative research and innovation with a strong industry pull, drives and de-risks take-up, leading to reliable and timely deployment of novel solutions. Effective alignment with insertion points have a key role to play in ensuring the benefits are maximised. The critical roles that people and culture play are recognised.

What is in place now

- A focussed and compelling Rail Technical Strategy that enables prioritisation of efforts in the shorter term with a clear longer-term direction of travel.
- Pockets of business driven innovation where targeted initiatives have been established to solve specific business problems.
- Coordinated and aligned publicly funded research, development and innovation pipelines.
- Pipelines of R&D and Innovation balanced across incremental and step-change solutions, covering a wide range of Rail Industry Readiness Level (RIRLs), with industry driving the incremental and higher RIRL initiatives.
- An increasingly devolved industry where train operators and infrastructure managers can identify, lead and deploy solutions to benefit regional and local customers and other beneficiaries.
- Key Train Requirements encouraging and supporting the adoption of best practice and recently acquired knowledge on rolling stock.
- Research planning incorporates the development of possible options and routes to deployment, recognising the potential owners and the necessary actions.
- Closer relationships between supply chain, academia and industry established, overcoming barriers to progression of research into development and innovation.
- A framework for establishing product, system or service readiness - Rail Industry Readiness Levels (RIRLs).
- Process and commitment to challenge standards.

What we are working on

- Scaling up the level of engagement of business leaders and front-line teams with innovation.
- Increasing the visibility of work and initiatives, led by different organisations across the sector, that are relevant to the five RTS functional priorities.
- Improving the level of awareness of important new findings and solutions emerging from R&D.
- Planning and scheduling of testing and in-service piloting while R&D is underway.
- Exploiting further newly created opportunities and mechanisms to collaborate across the value chain and bring together different expertise, as successfully demonstrated by UKRRIN.
- Ensuring that sound safety-thinking and effective standards enable innovative solutions and their deployment.
- Identifying insertion points for the introduction of new technology at an early stage in its development and taking proactive action to deliver in time to meet them.
- Connecting the RTS with wider transport and government initiatives to draw support from, and share success with other sectors.
- Scanning across sectors for fast moving and high-potential technologies and disruptors that could significantly impact railway operation and user experience.

Where we need to get to

- All businesses, and the individuals, which work in rail recognise that driving innovation and investing in solutions beyond the needs of today's railway is imperative.
- Industry leaders commit to sponsoring solutions to long-term challenges.
- Research delivery is prioritised and timed to maximise deployment and implementation opportunities, and is overseen and steered by empowered cross-industry entities.
- New solutions are developed in ways which de-risk their introduction with better use of system integration, simulations and modelling tools.
- Key requirements (similar to the Key Train Requirements) developed for other railway systems, underpinned by dynamic, technology agnostic standards, to inform compatibility and facilitate innovation.
- Industry investment plans routinely draw on R&D outputs and the risks associated with their initial deployment are recognised, accepted and appropriately managed.
- Clear routes to develop solutions, and the associated business cases, through the RIRLs toward full market readiness are well understood and used.
- New commercial models to support deployment of new technologies and wider innovation makes innovation in rail more attractive for both public and private funders.



DIGITALLY TALENTED WORKFORCE



Attracting and developing a vibrant and more diverse workforce is critical. The fast-paced developments of digital technologies pose a further attraction, retention and upskilling challenge. The railway continues to need people from a vast array of technical backgrounds and this increasingly needs to be underpinned by strong digital skills to successfully drive change and innovation.

What is in place now

- Well-established organisations and initiatives focused on attracting and retaining diverse people to the industry, including The National Skills Academy for Rail, the National College for Advanced Transport & Infrastructure and Women in Rail.
- Continual Professional Development and networking programmes run by institutions with rail divisions including IMechE, IET, IRSE and PWI.
- Increased awareness of the importance of digital skills.

What we are working on

- Attracting more people skilled in non-traditional rail technical disciplines such as cyber security and new data analytics.
- Technology and soft solutions to maintain high levels of staff physical and mental well-being.
- New approaches to problem-solving including hackathons to encourage and inspire a more diverse range of start-ups, individuals and SMEs to engage in rail.

Where we need to get to

- The railway workforce evolves symbiotically with emerging technical change and is routinely involved in the generation of ideas and solutions.
- Companies across the rail sector are set up to support, challenge and develop the new talent attracted by the variety of technical challenges, ways of working and pace of progress in the industry.
- Rail organisations are recognised as forward-thinking employers of choice that invest in the long-term development of technically skilled people with digital competence a core consideration.
- People working in rail embrace new technologies because they see them as an opportunity to deliver a better experience for customers, have a safer and more fulfilling job, and gain skills as part of career development.



DESIRED OUTCOMES

The Rail Technical Strategy exists to help industry deliver for its customers. It is a live, evolving strategy designed to reflect the changing landscape, celebrate successes and highlight where further effort and attention is needed to unlock technical progress.

These outcomes set out what success looks like for the strategy.

1	Support rapid progress towards industry's strategic aims	The RTS is part of a bigger strategic picture, showcasing the industry's agreed areas of technical focus and the pathway towards key goals. The goals for each functional priority have been mapped to show how progressing towards them will underpin progress towards the Strategic Objectives for Rail, and targets within other cross-industry strategies.
2	Steer research funding and initiatives to prioritise advances in agreed areas	Public-funded research, development and innovation entities will give precedence to supporting activities that have a clear link to the goals and stepping stones set out in the RTS. This allows the wider research community, including commercial R&D, to collaboratively schedule multi-stage initiatives effectively.
3	Inform long-term investment planning for replacements and renewals	Budget holders for capital investment and operational costs understand the status of technological solutions, allowing them to plan for upgrade / overhaul / replacement.
4	Empower supply chain to deliver the technical solutions required by industry	Major contractors through to SMEs and startups can target their development efforts and funds towards technological solutions with the confidence that there is a clear need for them. Better sight of the insertion points in line with longer-term planning will provide information on the timing and scale of market opportunities.
5	Foster collaboration and provide a conduit for sharing successes and challenges	Through the development and ongoing monitoring of progress against the strategy itself, plus the collaboration mechanisms established via the RTS website, the right parties are brought together to achieve the shared goals.

Engage with the RTS



Explore the full strategy including the live components at:

www.RailTechnicalStrategy.co.uk

A live strategy for everyone to engage with

A solid strategic plan is just the first step of the journey towards achieving the aims set out. Major progress within industry cannot be achieved by one party, but requires joined-up efforts from many players, and this is definitely the case for the rail industry and the RTS. To deliver the short- and longer-term goals set out in the strategy, the whole industry and supply chain will need to continue to work together, including securing input from outside of the rail sector.

Since the Covid-19 pandemic and the previous version of this strategy in 2020, there have been significant and long-term changes in the way we live and travel. These have required the railway to rethink its proposition to its customers and wider society, and the best structure to deliver it. This digital, living RTS aims to inform and complement this thinking as it continues to evolve, ensuring that it is aware of the technical solutions available and that future technical developments remain relevant to the strategic direction of the rail industry.



Share the technical solutions you are developing and deploying

For the strategy to evolve and remain current, it needs to capture what wider industry is delivering or considering initiating in relationship to the five functional priorities and the enablers. The 'Who is doing what?' section of the website for each priority is set up to welcome (and then share) inputs from all parties, so we invite you all to let us know what you are working on.

Further, we have an established series of meetings that seek to share current and upcoming activities across different research programmes and funding streams. The R&D Coordination Group performs deep-dives into the RTS functional priorities, helping raise awareness, align efforts and discuss these developments.

Also, we are looking to expand the range of case studies featured in the RTS. These have a key role in helping the railway to celebrate and publicise its technical successes and learn lessons, so please share your stories with the working group. The aim is to help potential partners and customers find you and understand what is available whilst protecting your IPR.

Your feedback is welcome

The need is not only for individuals and organisations to add to the picture, but also to constructively challenge the direction of travel and its speed. In particular, we are always interested to know about new ideas and opportunities to accelerate towards the stated vision for 2040. Sharing thoughts across industry on these matters will be invaluable in continuing to challenge ourselves and make rapid, positive progress.

Get in touch at:

rts@rssb.co.uk

