Rail Technical Strategy

Innovating across Britain's railway

Rail Technical Strategy
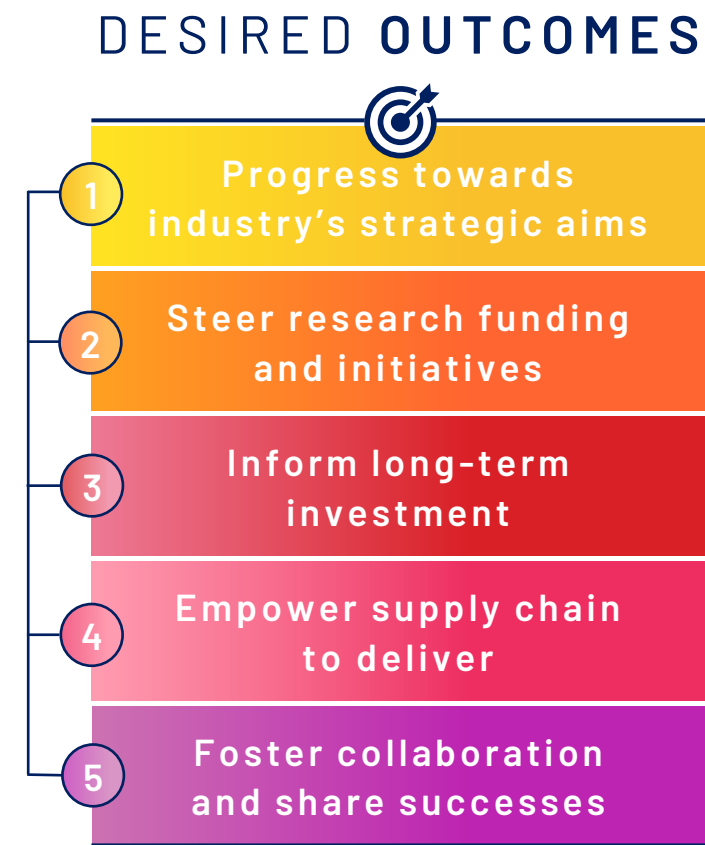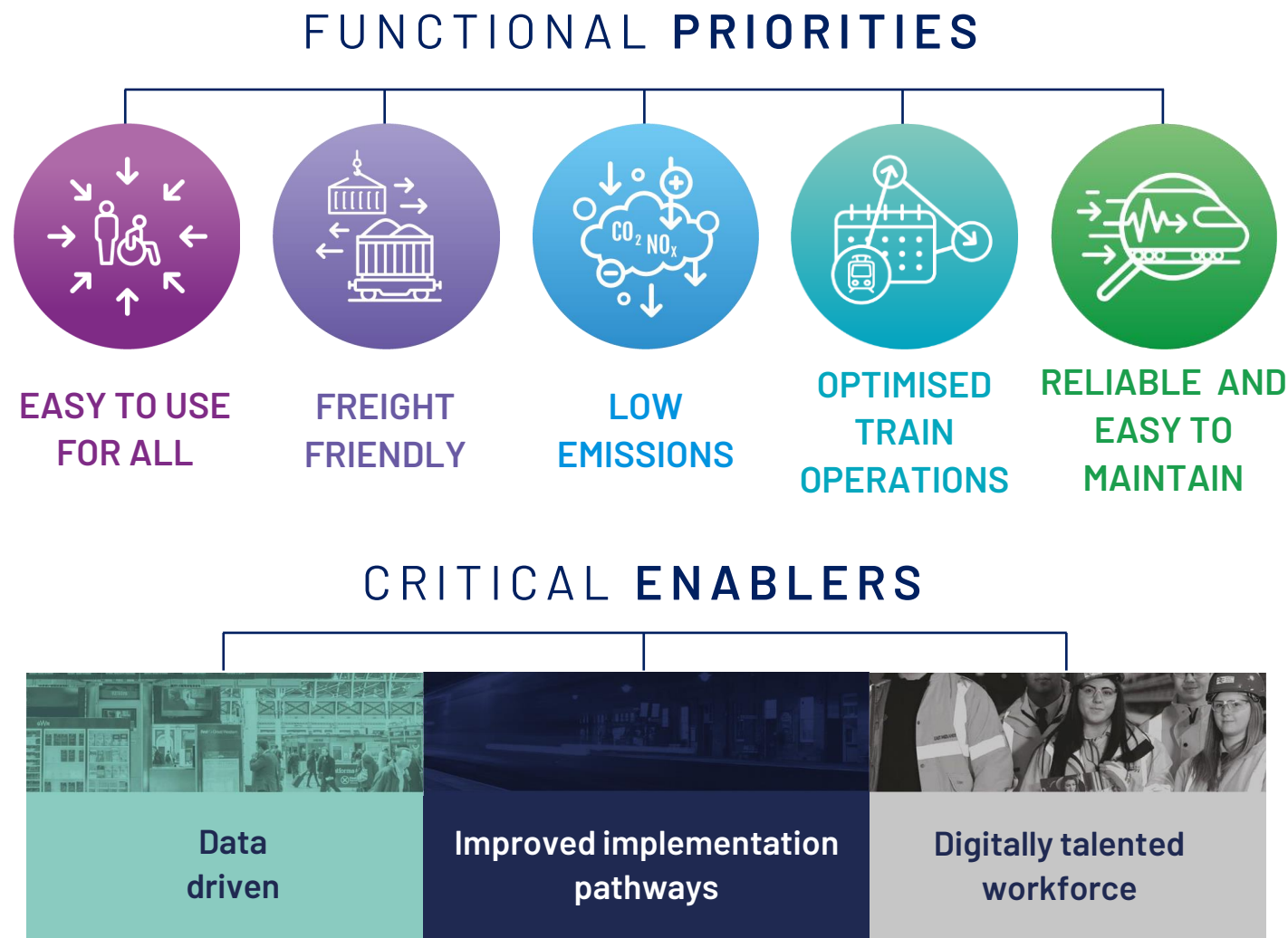## Innovating across Britain's railway

CONTENTS

Rail Technical Strategy
Innovating across Britain's railway

FUNCTIONAL PRIORITIES

EASY TO USE FOR ALL

FREIGHT FRIENDLY

LOW EMISSIONS

OPTIMISED TRAIN OPERATIONS

RELIABLE AND EASY TO MAINTAIN

CRITICAL ENABLERS

Data driven

Improved implementation pathways

Digitally talented workforce

DESIRED OUTCOMES

1. Progress towards industry's strategic aims
2. Steer research funding and initiatives
3. Inform long-term investment
4. Empower supply chain to deliver
5. Foster collaboration and share successes

Rail Technical Strategy
Innovating across Britain's railway

Andrew Haines

FOREWORD

The updated Rail Technical Strategy is a major shift for the industry. It outlines how we are making a step change in innovation across the rail sector.

We've been too slow on innovation and it is time that we reset. The COVID pandemic has demonstrated that we can be more agile and deliver better for passengers and freight users. We must recognise the importance of innovation beyond today and find longer term solutions fit for the future of rail.

This strategy provides us with a spring-board to address long-standing challenges that the rail industry has faced. We have an opportunity now, with this strategy, to build long-term solutions in areas such as environmental sustainability, affordability, reliability and safety.

Network Rail is committed to this and we are investing £245m in Research and Development in this control period through our R&D Portfolio. This funding is being used to deliver improvements and accelerate the development and introduction of technology - from an app to underpin passenger assistance, to modernising the way our frontline teams collect and make use of data through wearable technology; delivering medium term solutions that keep trains moving when parts of the signalling system fail along with replacing our ageing signalling assets in a way that is affordable and timely; delivering longer term improvements to address sustainability challenges and finding affordable ways to achieve resilience against the backdrop of climate change.

These examples and all R&D projects are being delivered by collaborating across industry with operators, suppliers, universities and many other organisations. Collaboration is at the heart of this strategy which couldn't have been developed in isolation. We can only succeed when we work together, as one rail industry.

Let's embrace this strategy, reset our expectations to harness technology and build on this platform for change.

Andrew Haines
Chief Executive, Network Rail

2020

Rail Technical Strategy
Innovating across Britain's railway
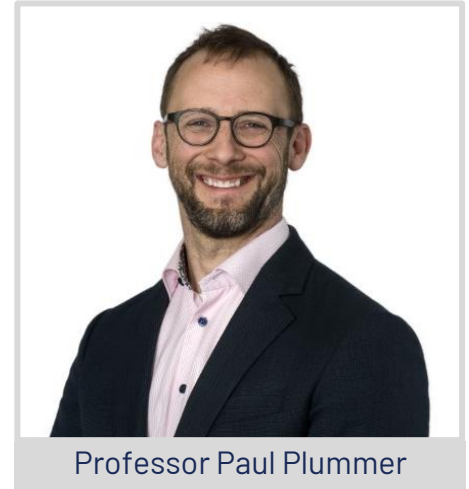

Professor Paul Plummer

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

Darren Caplan

The UK is the home of the railways, having invented and built the first rail network in the world. Throughout the years, the UK rail industry has been at the forefront of innovation, delivering new technologies that have better connected communities, empowered passengers, enabled our freight industry to move goods around the country, and supported a growing national economy.

However, in modern times, our railways face great challenges, from the Coronavirus pandemic, to the need to decarbonise rail to the continuing move to a more digitalised and data-driven society. We also need a skilled, diverse workforce to deliver the railway network of the future.

These challenges will require inventive thinking, collaboration across the railway industry and the exploration and exploitation of new technologies, so rail can improve its offer to customers and help the sector deliver even more for UK plc. These solutions will have many forms, whether it's through the materials we use, the automation of certain activities or the use of less energy-intensive processes, to name a few.

This Rail Technical Strategy provides the path for doing this, setting out five priorities and the enablers that will support this progress. 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, thereby producing even more from the UK's £36 billion railway industry. I would urge all, whatever the size or discipline of your organisation, to get involved with this important work.

Whilst there are significant challenges before the industry, 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, retaining our position as the home of the railways.

Darren Caplan
Chief Executive, Railway Industry Association

Rail Technical Strategy
Innovating across Britain's railway

Mark Phillips

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.

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

May 2024

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.

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.

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

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.

Rail Technical Strategy
### Innovating across Britain's railway

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 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.
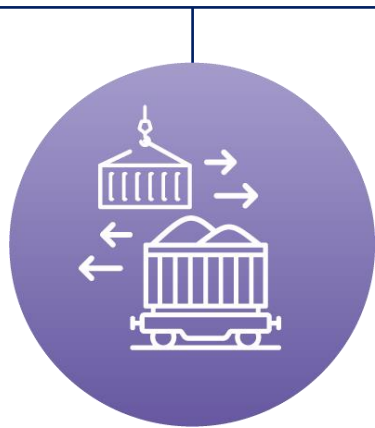
FREIGHT FRIENDLY

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.
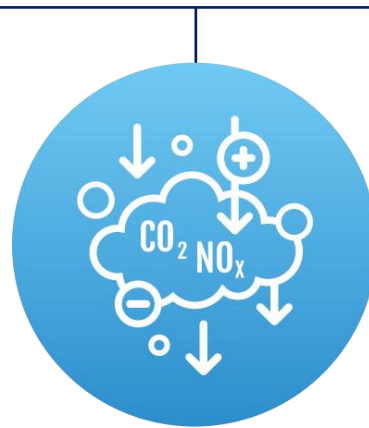
LOW EMISSIONS

Carbon and air emissions will be minimised by cheaper and less disruptive electrification, zero-carbon diesel replacement, greater efficiency and removing emissions at source.

OPTIMISED TRAIN OPERATIONS

Train services will be reliable and the capacity of the network improved by real-time management, better train planning and simulation, and shorter headways together with new solutions at nodes.
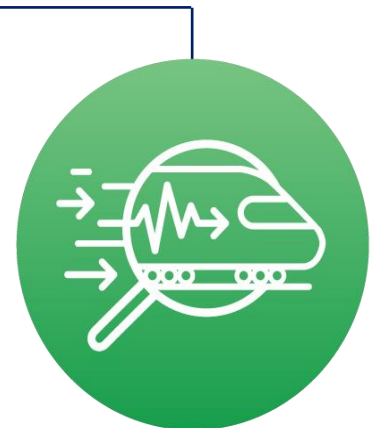
RELIABLE AND EASY TO MAINTAIN

Reliability and availability will be maximised by design, remote and automatic inspection, and targeted interventions, while whole-life cost is reduced.

Easy to use for all

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.

GOALS	WHY?	RECENT POSITION (2020)	STEPPING STONES IN THE NEXT FIVE YEARS			VISION FOR 2025	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.	Customers receive inclusive real-time information on journeys (including alternatives when disruptions occur) minimising stress and lost time, and boosting confidence.	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.	Payment and reservation experience for rail is easier and more inclusive for all journeys. Increased passenger confidence that they've got a valid ticket at the best value.	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. (Specific) real-time passenger feedback is proactively sought and made easy to provide.	Open data and AI enhance the level of customisation of support and services. 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.	Information on passenger movements, preferences and needs allows customised support and services that improve the experience of travelling by rail.	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.	Deployment plan and guidance to speed up the adoption of existing step-free solutions (e.g. humps and low-floor trains). Roll out tools for people with less visible disabilities to use the railway. Inclusive design tools and measures to assess and cater for all capability losses are developed and used to inform stretching inclusion targets.	Assess new solutions to remove hazards and barriers for people with reduced mobility (e.g. gateless access and crowding control). Account-based digital services make booking and providing assistance easier.		Passengers with capability impairments are better catered for. Inclusive design tools and measures drive action to maximise the proportion of the population who find the railway easy to use.	
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. Data exchange in place to allow better connection decisions by transport operators and the travelling public.	Develop operational concepts and facilities for connections with emerging modes (including micro-mobility). Feasibility studies on tools to optimise passenger flow within and across modes.		Passengers' first and last mile are better understood and catered for.	Railway plays a key role in the provision of door-to-door, not just point-to-point, transportation. 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.	

Easy to use for all
Progress against short-term vision

GOALS	RECENT POSITION (2020)	RECENT PROGRESS AGAINST STEPPING STONES			VISION FOR 2025
Accurate, accessible and understandable real-time information	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. RDG The second iteration of the Smarter Information Smarter Journeys programme (SISJv2) launched in April 2023 includes work packages due to deliver in 2024-2025.	Personalised information sent to customers based on their journey and travelling patterns. RDG SISJv2 sets out plans for the Customer Information journey experience of the future. Northern is offering live train info via a WhatsApp chatbot. Development of biosafety indicators that support customers and industry decisions. RSSB The LHBR programme published a Pandemic Playbook and Lesson's Learned report capturing insights from the Covid-19 pandemic to inform future planning.	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. RDG EMR launched a free multi-modal planner in June 2023, with personalised journey assistance provided through EMR Messenger.	Customers receive inclusive real-time information on journeys (including alternatives when disruptions occur) minimising stress and lost time, and boosting confidence.
Smart fare collection	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). RDG Contactless 'tap-in' payments being rolled out across 53 stations in the South East by the end of 2023. Account-based ticketing underpins the Digital Fares and Ticketing Platform to allow simplification and personalisation. GBR DfT & RDG TfL's Project Proteus plans to evolve Oyster closed-loop contactless ticketing to an account-based system, with a contract award in August 2024	Smart ticketing on mobile devices to improve reservation and personalisation for less frequent, longer, more expensive journeys. DfT & RDG Launch of Rail Online in the UK in May 2023 which is offering operator fare price matching, instant refunds on e-tickets, and no booking fees. Digital Fares and Ticketing Platform enables richer services to passengers and third parties. GBRTT Fares, Ticketing and Retail Review launched.	Open data and suitable commercial agreements deliver multi-modal ticketing provision. RDG An Urban Transport Group paper and set of recommendations was published November 2022.	Payment and reservation experience for rail is easier and more inclusive for all journeys. Increased passenger confidence that they've got a valid ticket at the best value.
Personalised services	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. GBRTT Fares, Ticketing and Retail Review aims to develop a more modern retail experience, a rollout of digital ticketing across the network, contactless and pay as you go systems in urban areas, and "simplified, best-available value-for-money options on journeys outside urban areas". (Specific) real-time passenger feedback is proactively sought and made easy to provide. DfT GWR trial of Whoosh digital platform that includes patented 'Tell Us' functionality to enable contextualised fault reporting by passengers and staff onboard.	Passenger centric measures of rail performance are identified and used. Transport Focus HS2 concepts to be trialled on AWC to set new customer experience standards, including comfort and personalisation.	Open data and AI enhance the level of customisation of support and services. Suppliers Transport Research & Innovation Grant funding awarded to six 'technologies of the future' projects to improve rail passenger experience in June 2023 . New design solutions on trains make on-board tasks and activities easier and more pleasant. UKRRIN PriestmanGoode launched Green Carriage in November 2022 which allows for modular interiors that adapt to passenger requirements.	Information on passenger movements, preferences and needs allows customised support and services that improve the experience of travelling by rail.
Accessible to all	Focus is mainly on step-free access to stations and platforms with limited initiatives for other capability impairments.	Deployment plan and guidance to speed up the adoption of existing step-free solutions (e.g. humps and low-floor trains). TfL has published results of its consultation on the future of step-free access on the Tube network, announced ten stations to be reviewed for priority step-free access, and trialled a new bridging device. Roll out tools for people with less visible disabilities to use the railway. NR CE NaviLens, an app designed to help blind or partially-sighted customers navigate stations, trialled on DLR. SWR trial using AI to translate passenger info into British Sign Language displayed on totem screens at Waterloo. Inclusive design tools and measures to assess and cater for all capability losses are developed and used to inform stretching inclusion targets. Various	Account-based digital services make booking and providing assistance easier. RDG ORR survey found 75% of users highly likely to recommend Passenger Assist. Operators delivering training to accompany the roll-out of the Passenger Assist staff app.	Assess new solutions to remove hazards and barriers for people with reduced mobility (e.g. gateless access and crowding control). GBRTT Station accessibility audit completed and National Rail Accessibility Strategy due to be launched.	Passengers with capability impairments are better catered for. Inclusive design tools and measures drive action to maximise the proportion of the population who find the railway easy to use.
Door to door solutions	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. CPC, RDG and NR Reading Green Park Station, a new multi-modal interchange designed to improve accessibility and connectivity, opened in May 2023. A regional transport integration hub at Motherwell Station was opened in June 2023. Data exchange in place to allow better connection decisions by transport operators and the travelling public. RDG & NR Transport for West Midlands is developing a single app and single account solution to support planning and decision making across all transport modes.	Feasibility studies on tools to optimise passenger flow within and across modes. TBD The TRIB Transport Digital Twin Vision and Roadmap to 2035 was published, announcing an intention to facilitate connected digital twins across different transport modes by 2035.	Develop operational concepts and facilities for connections with emerging modes (including micro-mobility). TBD Tier e-bikes and scooters have been integrated with the Whoosh app to enable onward journeys for rail passengers in London.	Passengers' first and last mile are better understood and catered for.
Reliable and fast on-board connectivity	Phone and mobile data coverage on trains is patchy and unreliable.	Lessons learnt from 5G trials inform technical and commercial plans. NR SWR and NR continue roll out of Evo-rail's multi-gigabit solution, using self-powered trackside infrastructure. Neos selected as preferred supplier for NR's Project Reach.	Agreed overall plan to improve rail connectivity starts to be delivered. DfT & NR UK Government's Wireless Infrastructure Strategy, which includes delivering digital infrastructure to improve mobile coverage for rail, published in April 2023.	Regular reports on the extent and quality of mobile coverage on the railways are in place. Ofcom Wireless Infrastructure Strategy included a commitment to work with Ofcom to improve reporting of rail network coverage.	Good on-board voice and data connectivity is a given when travelling by rail.

Suggested industry-level owners are underlined.   AWC – Avanti West Coast   DfT – Department for Transport   CPC – Connected Places Catapult   DLR – Docklands Light Railway   GBRTT – Great British Railways Transition Team   GWR – Great Western Railway   LHSBR – Leading Health and Safety on Britain's Railways   NR – Network Rail   NR CE – Network Rail Customer Experience Team   ORR – Office of Rail and Road   RDG – Rail Delivery Group   SISJv2 - Smarter Information Smarter Journeys programme v2   SWR – South Western Railway   TfL - Transport for London   TRIB – Transport Research & Innovation Board   UKRRIN – UK Rail Research & Innovation Network

Freight friendly

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

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.
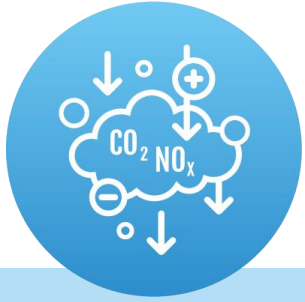
Maggie Simpson
Director General
Rail Freight Group

GOALS	WHY?	2024 STATUS	STEPPING STONES OVER THE NEXT 5 TO 8 YEARS	FURTHER STEPS TOWARDS 2040	VISION FOR 2040
Increased network access for freight	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. • Improve industry visibility of current and future route availability for Heavy Axle Weight freight services to allow for better and more informed asset management. • Embed and exploit changes to W10 and W12 definitions that accommodate more wagon/box combinations over greater parts of the network. • Develop robust engineering models that characterise the impact of maintenance costs associated with Heavy Axle Weight traffic. • 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. • Assess the case for targeted deployment of track design solutions to minimise the impact of freight traffic. • 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).	Systems are updated 'right-time' to maximise freight train length, size and weight for given route infrastructure and rolling stock capabilities, as well as timetable demands.	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.
Safer freight operations and better asset management	Better monitoring of freight assets allows failure prediction and timely proactive timely 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. • 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. • 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. • Assess the feasibility of cameras, sensors and other technology in undertaking train safety checks within terminals, thus removing exposure to dangerous tasks. • 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. • Explore freight specific options and requirements for remote condition monitoring (RCM) solutions alongside wider industry RCM requirements. Assess the business case for tactical deployment.	Full adoption and on-going improvements of RCM insight allows for more effective and efficient responses to asset degradation. Technologies that support the automation of freight train movements within terminals starts to be rolled out.	Sudden asset failures and associated incidents on the network are regularly and successfully prevented. Yards are significantly safer with workforce exposure to risk minimised.
Enable greater intermodality and access for freight customers	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. • Explore growth opportunities using parts of the existing network by providing flexible and temporary loading sites, in addition to fixed terminal/yard infrastructure • Assess modular and low-cost signalling systems to support quicker and cheaper connections to off-network locations. • Develop industry systems to provide an easier understanding of how rail can serve their customers' logistics needs.	Embed mechanisms and systems to support customers wanting to transport their goods by rail with ease of comparison against other modes.	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.
Greater asset utilisation and reduced freight journey times	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. • 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. • Explore options for the safe application of higher maximum permissible speeds to increase capacity and unlock new paths through reduced block occupation times. • Agree and implement changes to the Network Code to support the deployment of freight friendly pathing that recognises the economic importance of freight services. • 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 is underpinned by improved freight pathing algorithms. • 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.	Integration of timetable planning, traffic management and connected driver advisory systems with right-time changes in freight train and network capabilities.	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.
Low carbon freight and On Track Machines	There is currently no viable alternative to electrification or diesel to deliver the power necessary to the full range of freight journeys. Without action, rail freight risks being penalised even if alternative modes may be more carbon intensive and increase congestion.	There is no clear path to freight decarbonisation beyond the introduction of multimodal vehicle and limited use of alternative fuels. Spikes in electricity prices following the Russian invasion of Ukraine led to greater use of diesel traction. Industry is looking into maximising the benefits of future electrification for freight, as well as introducing and benefitting from hybrid and bi-/tri-mode locomotives.	Assess freight power options by understanding capabilities of the electrified network, current and future traction options, and what future electrification could look like for freight. • Explore the feasibility of intelligent/dynamic freight consist arrangements to reduce aerodynamic drag. • Explore optimised electrification designs and solutions for secondary freight-only routes. • Assess the feasibility of novel low carbon alternative fuels and associated changes to engines that would be needed. • Assess low-cost electrification options at terminals. • Explore options for integrated charging facilities for both road and rail at terminals.	Agree and pursue pathways to freight decarbonisation.	Clear role and relevance for rail as part of overall net zero logistics chain.

Low emissions

Carbon and air emissions will be minimised by cheaper and less disruptive electrification, zero-carbon diesel replacement, greater efficiency and removing emissions at source.

Better air quality is key to the health of our passengers, staff and wider society. A fully decarbonised and energy efficient railway will ensure that the sector plays a key role in meeting net zero carbon ambitions for the transport sector.

Key goals

- Cheaper and less disruptive electrification
- Zero-carbon self-powered vehicles
- Low carbon freight
- Increased energy efficiency
- Reducing polluting emissions

Malcolm Brown
CEO
Angel Trains
Chair of the Decarbonisation Taskforce

"It is no longer a question of what's the business case, but what's the fastest and most efficient track to get to a net zero carbon railway."
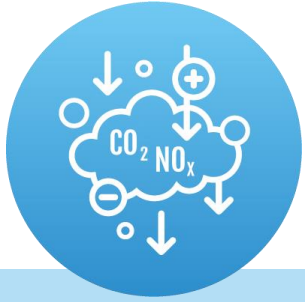
Low emissions

Malcolm Brown
CEO
Angel Trains
*Chair of the
Decarbonisation Taskforce*

Climate change is the biggest threat we face globally. It is already having impacts on the environment and society and will increasingly impact on the economy too. The need to do everything we can to limit the impact is critical and urgent.

Rail is a low carbon mode of transport, that has much to be proud of, but as the report of the industry's Decarbonisation Taskforce made clear – there is more we can, and must, do. The Government's legally binding commitment to a net zero carbon economy has led to the DfT's Transport Decarbonisation Plan. This is a game changer. All sectors that can get to zero will have to. It is no longer a question of what's the business case, but what's the fastest and most efficient track to zero. This challenge area sets out the technical route to delivery for traction energy. We have decided to focus on traction as both the largest element of rail's footprint, and also the one that is most specific to rail.

As the Transport Decarbonisation Plan makes clear, rail can play a significant role through modal shift. Taking passengers and freight on those journeys which would otherwise be made by a more polluting mode. As automotive moves to electrify the perception of rail's advantage may change – however, we should remember that 70% of our passenger train miles are already electric and through bi-mode technology, we can take that to 80% without any new infrastructure. However, as the Traction Decarbonisation Network Strategy has made clear, electrification will be an important element to a decarbonised railway – especially where we run at higher speeds or frequencies, and on key freight flows. We now need to focus on reducing the cost and disruption of new wires.

But we're not going to electrify the whole network so we also need to be accelerating the take up of new traction technologies such as hydrogen and battery. It is not a case of either electrification or alternative power – we will need both. Over the next decade or so, the need to replace over 1000 sprinter vehicles gives the potential for a step change in zero emission self powered vehicles on the network. We mustn't waste this chance.

New trains and new wires are not the only solution though and given the urgency of the challenge we also need to be focussing on the current fleet and the existing network. Efficiency is an often neglected opportunity to reduce carbon – whether it's on hotel load and system losses, or being able to optimise the timetable for low carbon. The impact this could have for rail freight, which faces the greatest technical challenge in decarbonising, is huge.

Solving some of these challenges will also help rail to play its part in improving air quality. Poor air quality is the biggest environmental health issue we face and one that is just as urgent as climate change, with an even more significant local impact on our communities. Increasingly as we look to address one, we need to consider the impact on the other.

This challenge area sets out five key issues and thirteen strategic stepping stones that can support the delivery of a genuinely low emissions railway that will continue to play a central role in the transport system of the future. Reaching each of these stepping stones will involve research, trials and implementation. There is much to do. But we cannot address this as a technical challenge alone. As the Decarbonisation Taskforce made clear: strong policy and governance, aligned incentives and clear accountability will also be key.

The industry is already making strides in these areas through the RSSB-led DECARB and CLEAR research programmes; and through Network Rail's Traction Decarbonisation Network Strategy. These provide strong foundations for the journey we need to make.

GOALS	WHY?	RECENT POSITION (2020)	STEPPING STONES IN THE NEXT FIVE YEARS				VISION FOR 2025	VISION FOR 2040
Cheaper and less disruptive electrification	More electrification is fundamental to zero emissions, as well as giving great acceleration, reliability and operating cost benefits.	Concerns over cost and disruption following recent electrification schemes have undermined political support.	Introduction of discontinuous electrification.	Rail has a clear power-supply strategy, including lineside storage, distributed generation, onboard and hydrogen. This takes account of smart grid, storage and load balancing opportunities.	Standards/incentives adopted to reduce the need for civil engineering while maintaining safety.	Faster, more detailed and more effective planning and route clearance is enabled.	New electrification schemes, including discontinuous electrification, are being developed to address cost and disruption challenges.	All high-speed and high-intensity lines are electrified.
Zero-carbon self-powered vehicles	Where maximum journey speeds are under 100mph, there is increasing optimism that hydrogen and batteries will deliver a cost-effective low-carbon alternative that still delivers against operational and timetable requirements.	There are around 2,500 <100mph diesel vehicles currently active, many of which run on lines unlikely to be electrified.	Standards for hydrogen and battery trains and associated infrastructure are adopted.		In-service fleet deployments for hydrogen- and battery-powered trains.		Clear transitional and replacement plans for Sprinters (Classes 150-159) delivering zero-carbon.	All self-powered passenger vehicles are zero carbon.
Low carbon freight	There is currently no viable alternative to electrification or diesel power for rail freight that delivers the necessary power. There is a need to maximise benefits from electrification, as well as from hybrid and bi-/tri-mode locomotives.	Rail freight, with its significant reliance on diesel, runs the risk of being penalised while alternative modes may be more carbon intensive and increase congestion.	Options, criteria and business case to retrofit traction options and alternative drop in fuels are developed.	Clear understanding of where electrification could provide tipping point for freight traction.		Energy-optimised timetable and real-time train speed profiles are enabled for off-peak operation.	Clear understanding of delivery roadmap and transition arrangements for low carbon freight.	Clear role for rail as part of overall net zero logistics chain.
Increased energy efficiency	Reducing energy consumption (losses and useful consumption) is often a cost-effective way to reduce carbon and can have immediate benefits for existing rolling stock.	The industry is neither incentivised nor aligned to improve the efficiency of rolling stock or infrastructure.	There is a strategy for reducing losses, especially on DC network as well as handling increased freight demand on the DC rail network.	Clear and agreed technical requirements for rolling stock efficiency and emissions reduction, including retrofit, are adopted.			Clear programme to reduce energy use is being delivered across the network.	Energy required per passenger vehicle km is minimised. Smart 'rail power network' that minimises traction carbon at source.
Reducing polluting emissions	Air quality is the most pressing environmental health risk in the UK. There is a need to balance the best route to long-term decarbonisation against the more pressing need to mitigate harmful air pollutants.	While overall emissions from rail are low, they can be significant locally. The industry currently has limited understanding of the scale, location and risk of emissions.	Low-cost intelligent emissions monitoring and risk mapping is in place.			A programme of trials to test and compare mitigation options is delivered.	Air Quality Improvement Plans are in place and in action at locations where one is required.	Rail has a negligible impact on local air quality.

Low emissions
Progress against short-term vision

RTS Innovating across Britain's railway

GOALS	RECENT POSITION (2020)	RECENT PROGRESS AGAINST STEPPING STONES				VISION FOR 2025
Cheaper and less disruptive electrification	Concerns over cost and disruption following recent electrification schemes have undermined political support.	Introduction of discontinuous electrification. Various TfW announced Class 230 battery-hybrid trains have been introduced into regular passenger service on the Borderlands Line between Wrexham and Bidston in April 2023. Class 756 electric-battery-diesel hybrid trains tested before entering service on the Rhymney line.	Rail has a clear power-supply strategy, including lineside storage, distributed generation, onboard and hydrogen. This takes account of smart grid, storage and load balancing opportunities. NR & RSSB. T1272 is exploring charging battery/multi-mode trains while running on the existing electrified network. T1229 will publish findings on non-electrified zones of high energy demand for freight trains in autumn 2023. T1270 will examine potential for intelligent energy management using the Western Route as a case study.	Standards/incentives adopted to reduce the need for civil engineering while maintaining safety. NR	Faster, more detailed and more effective planning and route clearance is enabled. NR TDNS	New electrification schemes, including discontinuous electrification, are being developed to address cost and disruption challenges.
Zero-carbon self-powered vehicles	There are around 2,500 <100mph diesel vehicles currently active, many of which run on lines unlikely to be electrified.	Standards for hydrogen and battery trains and associated infrastructure are adopted. RSSB T1185, an enabler to the operation of battery/multi bi-mode trains re. on-network charging has been published. T1272 will develop 'rules of engagement' between battery trains and traction power networks and examine the wider requirements.		In-service fleet deployments for hydrogen- and battery-powered trains. ROSCOs and academia HyTunnel project (COF=HYT-01) completed in 2023, results will inform decisions about safety equipment, systems and procedures to address hydrogen risks in tunnels. MultiHyFuel project (COF-MHY), risk assessment review of critical scenarios and hazardous areas underway, with best practice guidance due to be published in July 2024. Great Western Railway trial of battery train and fast-charging technology on the Greenford branch line.		Clear transitional and replacement arrangements for Sprinters (Classes 150-159) delivering zero carbon.
Low carbon freight	Rail freight, with its significant reliance on diesel, runs the risk of being penalised while alternative modes may be more carbon intensive and increase congestion.	Options, criteria and business case to retrofit traction options and alternative drop in fuels are developed. ROSCOs and manufacturers T1229 developed a model of traction power and energy requirements for freight corridors to improve understanding of the performance demands that low carbon freight locomotives will need to deliver.	Clear understanding of where electrification could provide tipping point for freight traction. NR TDNS, An aspect of T1263, which has completed with the technical report published in March 2023, explored opportunities to increase freight services where passenger services have been thinned out.	Energy-optimised timetable and real-time train speed profiles are enabled for off-peak operation. NR and RSSB T1263 has is developed a framework for freight-prioritised, low emissions pathing and regulation decisions. It considered the holistic impacts of whole network traffic and wide economic benefits of modal shift from road to rail to identity the optimised options. T1270 will assess options to regulate the traction power demand on the Western Route.		Clear understanding of delivery roadmap and transition arrangements for low carbon freight.
Increased energy efficiency	The industry is neither incentivised nor aligned to improve the efficiency of rolling stock or infrastructure.	There is a strategy for reducing losses, especially on DC network as well as handling increased freight demand on the DC rail network. NR HS1 shared findings from a project that involved the introduction of regenerative braking technology introduced on Southeastern trains.	Clear and agreed technical requirements for rolling stock efficiency and emissions reduction, including retrofit, are adopted. RSSB is finalizing the recommendation for Rail Air Quality Targets for the DfT. Guidance on the initial steps TOCs should take to produce Air Quality Improvement Plans will be produced by RSSB by September 2023.

SUS-2022-012 'Industry Idling Reduction Initiative' is underway and aims to deliver tangible reductions in engine idling with best practice guidance on how this can be maintained and repeated across industry. The project will understand barriers to idling reduction, assess technical solutions and perform a cost / benefit analysis on various mitigation options.

SUS-2022-030 'Onboard trains particulate matter speciation' is also underway and aim to further understand the sources, composition and potential health impact of particulate matters found onboard train. Tests and sampling will be completed by summer 2023. Report including mitigation measures will be finalised by end of 2023. | | | Clear programme to reduce energy use is being delivered across the network. |
| **Reducing polluting emissions** | While overall emissions from rail are low, they can be significant locally. The industry's understanding of the scale, location and risk of emissions is improving through the research and implementation carried out. | Low-cost intelligent emissions monitoring and risk mapping is in place. RSSB A Stations Air Quality Monitoring Network (AQMN), developed and operated by RSSB is in place covering over 100 stations. Diffusion tubes are installed at all stations covered, and three reference monitors have been installed so far, with two more to be installed by end of 2023. | | A programme of trials to test and compare mitigation options is delivered. Various T1235 developed a testing protocol for retrofit emissions mitigation options for diesel rolling stock. TOCs and ROSCOs are working on various mitigation options to reduce diesel emissions from their fleets as part of their National Rail Contracts and Business Plan Commitments. NR announced a trial of new purification devices at platforms 10 and 11 at Birmingham New Street. | | Air Quality Improvement Plans are in place and in action at locations where one is required. |

Suggested industry-level owners are underlined.   DfT – Department for Transport   GBRTT – Great British Railways Transition Team   NR – Network Rail   TDNS – Traction Decarbonisation Network Strategy   TfW – Transport for Wales

Optimised train operations

Train services will be reliable and the capacity of the network improved by real-time management, better train planning and simulation, and shorter headways together with new solutions at nodes.

High service reliability, more agile and robust train planning solutions, and improved solutions to better manage and increase capacity where needed are at the very heart of ensuring that rail retains and attracts new customers.

Key goals

- Flexible and reliable train planning
- Improved real-time operations and decisions
- Improved degraded operations
- Signalling and train capabilities support higher route capacity

Patrick Verwer
Chief Executive Officer
Govia Thameslink Railway

"Highly technical and sophisticated solutions to optimise train operations offer unprecedented opportunities, but we also need solutions that bring simplicity and agility to the way we operate the railway to deliver greater benefit to the customer more quickly."

Optimised train operations

Patrick Verwer
Chief Executive Officer
Govia Thameslink Railway

While there are many open-ended questions on the post-Covid demand from commuting and business travel, the poor level of service reliability that we delivered to our customers over the last few years made abundantly clear the impact that operating at full or close to full capacity had. Without developing and implementing new solutions to optimise train operations, the effect of any perturbation will remain significant and recovery to normal service challenging and time consuming.

Construction of HS2 will help to ease capacity pressure on the East and West Coast Mainlines, but that will take some time to deliver, and does not help in other parts of the country. In order to meet passengers' expectations of reliable services and cater for a changing demand, more effective, reliable and agile ways of utilising the existing capacity must be put in place.

Capacity can be used more efficiently for the benefit of passengers and freight customers through better planning processes, better on-the-day management, and by improving the performance of the assets that are the key determining factors: junctions, stations, track blocks, trains and platforms. Improving the performance of each of these components individually will help, but greater gains will be achieved with a whole-system approach. This whole-system thinking is a must if we are to deliver a reliable timetable today and a more agile and adaptable train service tomorrow.

Delivering optimised train operations starts with a more effective approach to the development of the working timetable enabled by improved data, processes and technologies. Capabilities and solutions are within reach to allow us to move toward more demand-based operations where the planning and re-planning of trains is agile and robust.

Improved real-time operations and decision making is key for quality of service both on 'a good day' and during disturbances. New powerful computing tools are increasingly being employed to create virtual systems which can be used to model the real world and investigate the impact of changes. Informed by rich real-time data, these tools can now be used to model railway operations, develop new insight on perturbation management including underlying pinch-points and propagation dynamics, and evaluate the effects of operational measures and changes to the timetable ahead of their introduction.

Modern trains have more effective, more controllable brakes and better acceleration than their predecessors, but will continue to operate on a mixed-traffic railway. Though there is potential for higher route capacity and performance improvement, these improvements will not be realised unless the train control systems, planning systems and the operating practices are adjusted to optimise journey times and coordinate train paths.

To successfully deliver against the vision for this priority, there is a lot to be done. Much centres around the deployment of novel technologies and the development of emerging ones, but this is not just a technology-based transformation. In GTR and our ATO partners we continue to learn lessons on the deployment of this technology, and one thing is certain: there is much more to making ATO a success than the technology. It is about smooth integration with signalling, new approaches to driver training, the level and spread of digital skills a company needs, and new ways to bridge the silos between different domains of railway knowledge, to name only a few aspects.

Highly technical and sophisticated solutions to optimise train operations offer unprecedented opportunities, but we also need solutions that bring simplicity and agility to the way we operate the railway to deliver greater benefit to the customer more quickly.

2020

Optimised train operations

GOALS	WHY?	RECENT POSITION (2020)	STEPPING STONES IN THE NEXT FIVE YEARS	VISION FOR 2025	VISION FOR 2040
Flexible and reliable train planning	There is a need to reduce the lead time and improve quality of future timetables. Easier and more robust ways to add / change paths at short notice allows services to be adjusted to meet passenger and freights needs.	The timetabling process has a long lead time and the working timetable generated doesn't learn from actual running times. The 'short-term' and 'very short-term' planning processes are very manual and not robust.	Single common model of GB rail infrastructure used for all planning. / Prioritised improvements of train planning data. / Greater integration of crew and stock planning for long and short term planning. / Solutions to allow the working timetable to learn from actual train performance. / Development and validation of new simulation tools to reflect the complexity of the railway and allow the outcomes of different optimisations to be compared and understood. / Solutions available to increase flexibility and robustness of very short-term planning.	Improved working timetable allocates allowances optimally, decreasing the risk of significant disruption if perturbations occur. / Train paths are added easily and reliably at short notice. Increased (predictable) quality of service during disturbances and faster recovery.	Demand-based operations: planning and re-planning of trains to meet customer needs can be achieved and communicated in near real-time. Timetable development is informed by real-world operational performance.
Improved real-time operations and decisions	Real-time train performance can be significantly improved by reducing the variability of train operations, and by improving traffic regulation and management during normal working and disruption.	Manual train handling leads to acceleration, braking and coasting lacking consistency. Initial deployments of Traffic Management (TM) and Connected Driver Advisory Systems (C-DAS) are used in a few locations. Shared understanding of where to deploy optimisation solutions and how to get best value out of them is limited. Richer data to better understand disruptions is starting to be explored. Incidences of Signals Passed at Danger remain a problem.	*(Open-source software infrastructure description)* — Crew and rolling stock resources linked to traffic management (TM). / TM integration with signalling systems. / Wider roll-out of TM to support, and where appropriate, automate decisions in perturbation. / Widespread roll-out of C-DAS in conjunction with TM to improve passenger and freight performance. / Elements of ATO-ETCS piloted to remove variability in driving profiles. / Agreed strategic deployment plan for driving task support systems to maximise value for money. / New data driven tools to prevent and help mitigate disruptions. / Define the capability gaps remaining to improved real-time operations and decisions during disruption. / Trial and initial fitment of ETCS Limited Supervision on non-ETCS infrastructure.	Strong business case in place for widespread roll-out of TM based on positive results from early implementations. / Reduction of variability in acceleration, braking and coasting on key route. / Data insight used to inform real-time decisions and to prevent disruption. / SPAD risk is virtually eliminated, with positive impact on service reliability.	Real-time optimisation of trains across the network together with effective prevention and recovery from disruptions. / All lines have or are migrating to a digital signalling solution.
Improved degraded operations	Current degraded working takes time to set up and significantly reduces throughput of trains.	Degraded Mode Working System (DMWS) has been developed in the lab but not yet piloted.	Mainline trials of DMWS. / Agreed deployment plan for DMWS which exploits quick wins enabled by some of its elements. / Exploration of alternative approaches including hybrid solutions that interface with the signalling system.	Reduced disruption during signalling failures.	
Signalling and train capabilities support higher route capacity	There is the need to fit more trains on those parts of the network that are full either because of headway lengths or because of bottlenecks at nodes.	Thameslink is successfully ramping up its capacity but traditional signalling and management of nodes continue to limit capacity on most of the network. The migration strategy to digital signalling is unclear. Conventional signalling is based on the worst performing train, which means that the improved performance of modern rolling stock in terms of braking and acceleration are not utilised. Reliable braking in low adhesion remains a challenge.	Agreed migration strategy and roll-out plan for radio based ETCS with no lineside signalling. / Lessons identified and implemented from Thameslink mainline ATO deployment over ETCS Level 2. / Optimised ETCS braking curves for freight. / Validated freight train integrity devices. / Enhanced train position systems. / Block lengths shortened and optimised by automated design for new schemes. / Faster operating, inherently safe, point mechanisms piloted. / Rationalisation of train classes and applicable speeds to create homogeneous operations.. / Fundamental review of operational principles for mixed-traffic. / Double variable rate sanders specified for new trains; prioritised retrofitting for existing trains. / Magnetic track brakes for all new, frequent stop trains. / Train doors and interior layouts optimised during overhaul and for new build to minimise dwell time.	Schemes deploying radio based ETCS with no lineside signals are in delivery. / The overlaying of ATO can be planned and delivered in a more informed way. / Capacity in the process of being increased at key bottlenecks thanks to better design and solutions. / Use of existing capacity is maximised / Predictable and reliable braking unaffected by railhead conditions.	Trains can run closer together safety.

Optimised train operations
Progress against short-term vision

GOALS | RECENT POSITION (2020) | RECENT PROGRESS AGAINST STEPPING STONES | VISION FOR 2025

Flexible and reliable train planning

Recent Position (2020):
- The timetabling process has a long lead time and the working timetable generated doesn't learn from actual running times.
- The 'short-term' and 'very short-term' planning processes are very manual and not robust.

Recent progress against stepping stones:
- Single common model of GB rail infrastructure used for all planning. NR SO
- Prioritised improvements of train planning data. NR SO
- Greater integration of crew and stock planning for long and short term planning. RSSB COF-G26 case study of Advanced Model Interface L3 of TM and Stock and Crew integration on ECML underway, due to complete 2024.
- Solutions to allow the working timetable to learn from actual train performance. NR SO
- Development and validation of new simulation tools to reflect the complexity of the railway and allow the outcomes of different optimisations to be compared and understood. NR SO, NR Target 190plus & UKRRIN NR Prior Information Notice for Target 190plus Synthetic Environment for the design and testing of signalling solutions published in July 2023.
- Solutions available to increase flexibility and robustness of very short term planning. RSSB and V/TC&C SIC 3Squared completed Solent Stevendores pilot to locate and load containers onto trains, and is refining an algorithm that shows probabilities of freight paths being used. Tracsis /Bellvedi path searching and automatic initiation of contingency plans now available.

Vision for 2025:
- Improved working timetable allocates allowances optimally, decreasing the risk of significant disruption if perturbations occur.
- Train paths are added easily and reliably at short notice. Increased (predictable) quality of service during disturbances and faster recovery.

Improved real-time operations and decisions

Recent Position (2020):
- Manual train handling leads to acceleration, braking and coasting lacking consistency.
- Initial deployments of Traffic management (TM) and Connected Driver Advisory Systems (C-DAS) are used in a few locations. Shared understanding of where to deploy optimisation solutions and how to get best value out of them is limited.
- Richer data to better understand disruptions is starting to be explored.
- Incidences of Signals Passed at Danger remain a problem.

(Side note: Open-source software infrastructure description. NR Project Axiom East Coast pilot underway (includes track, platform, S&C, signals and track circuit data). Proofs of concept include geospatial viewer, gradient data, data interoperability and automated schematics.)

Recent progress against stepping stones:
- Crew and rolling stock resources linked to traffic management (TM). NR Projects Western Route deployment of Integrale and Luminate, extended across Western Region and Anglia Route.
- TM integration with signalling systems. V/TC&C SIC Thameslink Class 700s to be upgraded following Class 387 testing, as part of the ECDP.
- Wider roll-out of TM to support, and where appropriate, automate decisions in perturbation. NR Regions National TM Strategy exploring the range of options for deployment.
- Widespread roll-out of C-DAS in conjunction with TM to improve passenger and freight performance. RSSB, V/TC&C SIC/DAS PCB Class 387s running with C-DAS operational, Class 802 operations not yet commenced. C-DAS benefits paper from operational trial expected Autumn 23.
- Elements of ATO-ETCS piloted to remove variability in driving profiles. V/TC&C SIC In use on Thameslink Core, with uptake of ATO increasing as new cohorts of drivers are trained.
- Agreed strategic deployment plan for driving task support systems to maximise value for money. NR Projects
- New data driven tools to prevent and help mitigate disruptions. RSSB, RDG, NR and TOCs NR Seasons Team is looking at the Seasonal Agnostic Railway Model and assessing the impact of asset failures.
- Define the capability gaps remaining to improved real-time operations and decisions during disruption. TBD Following IMP-T1154, NR is continuing roll out of the toolkit and associated processes, with 4 of 6 tranches completed, and the NOCs (to include CrossCountry and freight), due for completion by CP6 end.
- Trial and initial fitment of ETCS Limited Supervision on non-ETCS infrastructure. V/TC&C SIC/TPSG Proof of concept largely demonstrated on Class 150/2. Development has migrated to a speed management system with trials being planned on the West of England line with a Class 159, but funding is not yet secured.

Vision for 2025:
- Strong business case in place for widespread roll-out of TM based on positive results from early implementations.
- Reduction of variability in acceleration, braking and coasting on key routes.
- Data insight used to inform real-time decisions and to prevent disruption.
- SPAD risk is virtually eliminated, with positive impact on service reliability.

Improved degraded operations

Recent Position (2020):
- Degraded Mode Working System (DMWS) has been developed in the lab but not yet piloted.

Recent progress against stepping stones:
- Mainline trials of DMWS. V/TC&C SIC/DMWS *Plans for 'track-only' trial cancelled due to funding constraints.*
- Agreed deployment plan for DMWS which exploits quick wins enabled by some of its elements. V/TC&C SIC/DMWS
- Exploration of alternative approaches including hybrid solutions that interface with the signalling system. V/TC&C SIC/DMWS

Vision for 2025:
- Reduced disruption during signalling failures.

Signalling and train capabilities support higher route capacity

Recent Position (2020):
- Thameslink is successfully ramping up its capacity but traditional signalling and management of nodes continue to limit capacity on most of the network.
- The migration strategy to digital signalling is unclear.
- Conventional signalling is based on the worst performing train, which means that the improved performance of modern rolling stock in terms of braking and acceleration are not utilised.
- Reliable braking in low adhesion remains a challenge.

Recent progress against stepping stones:
- Agreed migration strategy and roll-out plan for radio based ETCS with no lineside signalling. V/TC&C SIC/TPSG ETCS pilot on Northern City Line (Moorgate–Finsbury Park complete and deployed. East Coast delivery programme continuing train and infrastructure fitment through 2024.
- Lessons identified and implemented from Thameslink mainline ATO deployment over ETCS Level 2. V/TC&C SIC/TPSG Included in the European ATO over ETCS (AoE) specifications, recently published in the updated CCS TSI. Learnings from DRACAS also available for AoE projects.
- Optimised ETCS braking curves for freight. V/TC&C SIC/TPSG
- Validated freight train integrity devices. RSSB, RFG Findings from T1264 provided GB freight industry with an evaluation framework and shared evidence base for introduction of Digital Automatic Coupling.
- Enhanced train position systems. Various
- Block lengths shortened and optimised by automated design for new schemes. V/TC&C SIC
- Faster operating, inherently safe, point mechanisms piloted. NR R&D & UKRRIN IN2TRACK3 project on redesigning actuators and simulating interlocking & actuators (based on REPOINT) due to complete end of 2023.
- Rationalisation of train classes and applicable speeds to create homogeneous operations. OPG and TOM SC T1266 is assessing the benefits of applying a speed differential based on the actual braking capabilities of freight trains using the same methodology that is required for ETCS and ERTMS. The final report is due to be published by the end of 2023.
- Fundamental review of operational principles for mixed-traffic. TBD Rail Partners' 'Freight Expectations' report published in March 2023 outlined the potential economic contribution of rail freight and calling for a set of commitments to support the shift from road to freight.
- Double variable rate sanders specified for new trains; prioritised retrofitting for existing trains RDG Fitments are underway with SWR n Class 158/9s, Northern Class 323s and Scotrail Class 170s.
- Magnetic track brakes for all new, frequent stop trains. ARG Testing of new Stadler-built Nexus metro fleet has now started ahead of entering passenger service in phases from 2023 –2025.
- Train doors and interior layouts optimised during overhaul and for new build to minimise dwell time. RSSB T1257 best practice on guard controlled door operation has been published and T1262 on Safe and Efficient Driver Controlled Door Operation underway.

Vision for 2025:
- Schemes deploying radio based ETCS with no lineside signals are in delivery.
- The overlaying of ATO can be planned and delivered in a more informed way.
- Capacity in the process of being increased at key bottlenecks thanks to better design and solutions.
- Use of existing capacity is maximised.
- Predictable and reliable braking unaffected by railhead conditions.

Suggested industry-level owners are underlined.

ARG – Adhesion Research Group   C-DAS - Connected Driver Advisory System   ECDP – East Coast Digital Programme   ETCS - European Train Control System   DAS PCB - Driver Advisory Systems Board   DMWS TPSG – Degraded Mode Working Systems   ECML East Coast Mainline   NOC - National Operations Centre   NR – Network Rail   NR SO – Network Rail Systems Operator   OPG - Operational Rules and Principles Group   RDG – Rail Delivery Group   RFG - Rail Freight Group   TM – Traffic Management   TOM SC - Traffic Operations Management Standards Committee   TPSG - Train Protection Strategy Group   UKRRIN – UK Rail Research & Innovation Network   V/TC&C SIC – Vehicle/Train Control & Communications Systems Interface Committee

v3.1 - September 2023

Reliable and easy to maintain

Reliability and availability will be maximised by design, remote and automatic inspection, and targeted interventions, while whole-life cost is reduced.

More reliable assets needing less out-of-service time are key to increased customer confidence and demand. Lower whole-life asset costs and increased understanding of how humans and machines can best work together, will help establish a thriving sector.

Key goals

- Improved reliability and availability of existing systems
- Safe and rapid inspection and repair
- Step-change in reliability, availability and whole-life cost for new assets

Dyan Crowther
Chief Executive Officer
HS1

"Reliability and availability underpins the experience of passengers and freight customers and to achieve that we must implement technology as system improvements rather than isolated projects."

Reliable and easy to maintain

Dyan Crowther
Chief Executive Officer
HS1

The reliability and availability of rolling stock and fixed infrastructure underpin the experience of passengers and freight customers.

Expectations are increasing whilst the operating environment is becoming more challenging. Assets need to be more resilient to cope with extreme weather events becoming more common and, under extreme conditions, to fail safely. Intensive use of assets drives up the need for maintenance whilst leaving smaller windows to carry it out and an often long life cycle creates a need to improve the performance of ageing assets.

New technology itself, whilst being a vital part of the answer, creates new challenges. In particular, the growing reliance of new technologies on software creates increasingly complex scenarios for potential failures.

The increasing expectations and use of the railway drives up costs. Yet at the same time there is pressure to offer better value to passengers and limit funding from the public purse. Assets need to do more but cost less, not just in terms of initial capital cost but their whole life cost. This requires new approaches to maintenance and life-extending techniques and materials as well as initial appraisal and selection for new assets. Other components to whole life cost, such as consideration of the circular economy, are becoming increasingly important to understand and enact.

We need to be pragmatic with the timing of deployment using key windows of opportunity, whether that's the refurbishment of a train fleet, the renewal of life-expired signalling or the political appetite to restore Beeching lines.

Above all, we must remember that the railway is a complex system and treat it as such, implementing system changes rather than isolated projects.

Technology and technical development have already played a significant role in improving the reliability of assets over recent years.

For fixed assets, reliability is up by more than 15% in the last five years. This has been achieved through investment and insight: investment in train-borne inspection equipment, monitoring, machine learning; insight through decision-support tools, combined with local knowledge from devolution, building a stronger understanding by local teams of their assets.

For rolling stock, reliability has simultaneously been improved and made more challenging by technical developments in monitoring combined new fleet introductions. Sharing best practice for fleet management has positively impacted reliability, together with stronger collaboration between operator, manufacturer, maintainer and depot.

Opportunities to create a reliable and easy to maintain railway exist across all assets and rely on progress against three goals:

Improved reliability and availability of existing systems is achieved by continuing to improve existing components in critical assets and developing pragmatic solutions for single points of failure present in legacy railway design.

Safe and rapid inspection and repair is achieved by increasing and improving automation. Key developments are autonomous inspection and repair tools sand techniques to reduce and ultimately remove the workforce from dangerous and repetitive tasks. And building understanding and confidence on how humans and machines will interface, including where responsibilities reside, are key to enabling these changes.

Step-change in reliability, availability and whole life cost for new assets is achieved by designing for reliability at component and system levels, ensuring easy 'plug and play' for maintenance and future upgrades and engaging our workforce in co-creating more value-adding roles through technology.

Innovating towards these goals across the railway, and proudly building on our technical achievements, will ensure a railway that can be safely and affordably maintained with minimal disruption. Creating a better future for our passengers and freight customers.

2020

Reliable and easy to maintain

GOALS	WHY?	RECENT POSITION (2020)	STEPPING STONES IN THE NEXT FIVE YEARS			VISION FOR 2025	VISION FOR 2040
Improved reliability and availability of existing systems	Reliability that is appropriate to the role of rolling stock and fixed assets in the system reduces disruption to services and drives cost efficiency through less maintenance. Services should only be disrupted as a last resort when assets fail. Increasingly complex railway systems raise the likelihood of service disruption through faulty interactions of assets or sub-systems. Greater resilience needed to cope with system stresses including climate change.	The timing of failures is unpredictable resulting in over-cautious inspection and maintenance or emergency intervention and delay. Response to faults can overlook, or take insufficient account of, wider operational implications. Individually reliable components and systems can interact to delay trains.	Identify rolling stock and fixed assets to be prioritised for improved reliability and availability, based on their performance impact.	For high-priority assets and their operations: identify and assess improvement options, and review fault response to ensure services can keep running with minimal disruptions.	For high-priority assets, pilot and roll-out improvements to the assets, their management, fault response and operating approaches that keep services running.	System resilient to many localised failures. Improved reliability by designing refinements that have high performance impact. Improved availability by accommodating failures to in-service assets with 'smarter' operations. Knowledge is routinely applied to improve system reliability, with the workforce guided by data and maintainers engaged in design.	System resilient to most localised failures. All assets performing with a known and appropriate level of reliability at component, sub-system and system levels and causing minimum disruptions.
			Agree principles and rules to report defects and repairs, allowing a system-level diagnosis of complex faults.	Pilot cross-industry reporting system to prove its benefits in managing complex faults.	Increase the range of assets covered by this reporting system and feed enhanced system-level requirements into design specifications.		
Safe and rapid inspection and repair	Targeted interventions based on the condition of rolling stock and fixed assets. Minimised downtime for maintenance and repairs can have significant positive impact on both costs and customer satisfaction. Lower risk to workforce and less disruption can be achieved by more automated inspection and repair methods, and decision support.	Progress towards optimal inspection and monitoring, but remote inspection and monitoring (RCM) and non-destructive testing is only used for a limited set of assets. Where deployed, RCM is starting to move workforce away from live operational environments. Most maintenance and repairs require rolling stock being temporarily removed from service or track possessions. Safety-driven initiatives to reduce workforce risk are focused on improving current procedures.	Identify which high-priority (cost and impact) rolling stock and fixed assets could best use RCM, aligned with available sensor and comms technology.	Deploy RCM systems to high-priority assets and use the data to optimise inspection, servicing and replacement schedules based on asset conditions and performance.	Develop and deploy RCM systems to more rolling stock and fixed assets. Evolve RCM algorithms to improve their prediction accuracy.	Condition-based inspection and maintenance (optimised for practicability) is widely used, replacing periodic inspection and maintenance. Widespread use of robotics and AI to identify – and in some cases rectify – asset faults. Workforce has been trained on remote supervision, leading to fewer and shorter withdrawals from service or track possessions and greater safety.	All assets inform owners about health, degradation of performance and remaining service life. Railway maintenance is highly automated. Workforce typically co-ordinate automated repairs in live operational environments, often remotely.
			Agree with industry and ORR the economic and safety case for condition-based inspection and maintenance.				
			Identify assets suitable for robotic and Artificial Intelligence (AI) inspection and maintenance.	Demonstrate robotic and AI inspections in live environments with remote supervision from the workforce. Prove initial robotic and AI repair concepts.	Roll out of robotics and AI inspection. Demonstrate robotic and AI repair solutions in live environments.		
Step-change in reliability, availability and whole-life cost for new assets	Future railway systems are designed to minimise single points of failure and deliver reliable service including under future climatic conditions. Upgrades of rolling stock and fixed assets are affordable and can deliver lower operating costs and a higher performing railway. Opportunity to create high-value, safe roles for our workforce, designed to exploit new asset capability.	The case for, and path to, next generation assets is not always clear and whole-life cost is considered too narrowly. New generation asset design is not always driven by reliability and availability, especially at a system level. Design thinking and enhancements to the current generation of assets provide insights to inform new specifications. Renewals and mid-life refurbishment present opportunities but are often used to replace like-for-similar.	Incorporate targets for Mean Time To Repair and Between Failures and ease of repair in asset specifications and sub-systems.	Develop revised design specifications incorporating design for reliability and avoiding single point of failure.	Use revised specifications when replacing assets.	Maintenance strategy and requirements are always specified at design stage as part of optimising whole-life cost. Key train and infrastructure requirements, or equivalents, set at an appropriate level of detail, system-level outputs and long-term asset strategy.	New assets designed for availability through non-disruptive repair; easy renewal; and reduced whole-life cost and environmental impact. New assets designed for reliability at system level and for future climatic conditions. They do not have single points of failure and include in-built health monitoring. Future transitioning and re-purposing of assets considered as part of design.
			Workforce and technologists co-create opportunities and co-design new way to exploit new technology for safety, reliability and value.		Pilot co-designed operating concepts and systems.		
			Identify priority retrofit solutions to deliver a step-change through asset upgrades.	Develop tools to plan and assess the case for transitions to step-change performance of assets.	Apply the tools to inform industry planning.		

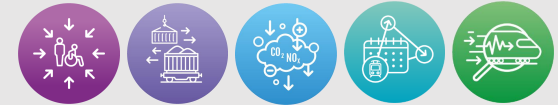| GOALS	WHY?	RECENT PROGRESS AGAINST STEPPING STONES			VISION FOR 2025
Improved reliability and availability of existing systems	Reliability that is appropriate to the role of rolling stock and fixed assets in the system reduces disruption to services and drives cost efficiency through less maintenance. Services should only be disrupted as a last resort when assets fail. Increasingly complex railway systems raise the likelihood of service disruption through faulty interactions of assets or sub-systems. Greater resilience needed to cope with system stresses including climate change.	Identify rolling stock and fixed assets to be prioritised for improved reliability and availability, based on their performance impact. Various Porterbook has opened a modern Asset Management Facility (AMF) at Long Marston Rail Innovation Centre, to support trialling and testing of innovative traction tech. NR and Arcadis pilot performance-based data analytics and technical insights model on 19km of Western Route.	For high-priority assets and their operations: identify and assess improvement options, and review fault response to ensure services can keep running with minimal disruptions. Various First-of-a-Kind Reliable and Maintainable Assets Rail competition for high maturity demonstrations launched in June 2023.	For high-priority assets, pilot and roll-out improvements to the assets, their management, fault response and operating approaches that keep services running. Various Northern equipping up to 40 Class 335 trains with LiDAR cameras, thermal imaging software and HD CCTV to record infrastructure defects, environmental factors and maintenance issues.	System resilient to many localised failures. Improved reliability by designing refinements that have high performance impact. Improved availability by accommodating failures to in-service assets with 'smarter' operations. Knowledge is routinely applied to improve system reliability, with the workforce guided by data and maintainers engaged in design.
		Agree principles and rules to report defects and repairs, allowing a system-level diagnosis of complex faults. Various RSSB published a Concept of Operations for the National CCS Defect Reporting Analysis and Corrective Action System (DRACAS), which has informed an update to RIS-0707-CCS.	Pilot cross-industry reporting system to prove its benefits in managing complex faults. Various The East Coast Deployment Programme is piloting an ETCS DRACAS tool with a small number of operators, starting with Grand Central, before rolling out to other operators in 2024. Lessons learnt will inform implementation and the development of a national system.	Increase the range of assets covered by this reporting system and feed enhanced system-level requirements into design specifications. Various The Asset Integrity Group (AIG) has created a roadmap for the implementation of the National CCS DRACAS.	
Safe and rapid inspection and repair	Targeted interventions based on the condition of rolling stock and fixed assets. Minimised downtime for maintenance and repairs can have significant positive impact on both costs and customer satisfaction. Lower risk to workforce and less disruption can be achieved by more automated inspection and repair methods, and decision support.	Identify which high-priority (cost and impact) rolling stock and fixed assets could best use RCM, aligned with available sensor and comms technology. Various NR's Intelligent Infrastructure (II) plans for CP7 includes a focus on predictive asset management and monitoring data to underpin decision making. Planning to be integrated across industry, aligning access and resources.	Deploy RCM systems to high-priority assets and use the data to optimise inspection, servicing and replacement schedules based on asset conditions and performance. Various NR's Intelligent Infrastructure (II) plans for CP7 includes plans to consolidate and exploit asset condition and usage data to optimise asset repairs and enhancements.	Develop and deploy RCM systems to more rolling stock and fixed assets. Evolve RCM algorithms to improve their prediction accuracy. Various Angel Trains and Cordel used LiDAR and co-located video, on the Didcot to Paddington route, to create a survey-grade digital twin aligned to NR's linear reference system. Data that is captured can be used to enhance the AI algorithms and deliver new insights for NR.	Condition-based inspection and maintenance (optimised for practicability) is widely used, replacing periodic inspection and maintenance. Widespread use of robotics and AI to identify – and in some cases rectify – asset faults. Workforce has been trained on remote supervision, leading to fewer and shorter withdrawals from service or track possessions and greater safety.
		Agree with industry and ORR the economic and safety case for condition-based inspection and maintenance. TBD *There is currently no clear mechanism to support the coordination necessary to understand the case and support transition from periodicities.*			
		Identify assets suitable for robotic and Artificial Intelligence (AI) inspection and maintenance. Various NR announced a partnership with Switzerland's national operator (SBB), which will focus on using AI to inspect steel bridges and track on the UK network.	Demonstrate robotic and AI inspections in live environments with remote supervision from the workforce. Prove initial robotic and AI repair concepts. Various One Big Circle's AIVR technology will be used in a NR pilot to monitor low adhesion in Wales during Autumn 2023.	Roll out of robotics and AI inspection. Demonstrate robotic and AI repair solutions in live environments. Various AAR Rail demonstrated its Automated Discrete Repair machine to NR in January 2023, with an in situ low pre-heat weld restoration process.	
Step-change in reliability, availability and whole-life cost for new assets	Future railway systems are designed to minimise single points of failure and deliver reliable service including under future climatic conditions. Upgrades of rolling stock and fixed assets are affordable and can deliver lower operating costs and a higher performing railway. Opportunity to create high-value, safe roles for our workforce, designed to exploit new asset capability.	Incorporate targets for Mean Time To Repair and Between Failures and ease of repair in asset specifications and sub-systems. Various New Greater Anglia/Stadler FLIRT bi-mode fleets achieving punctuality figures between 93% and 99% on routes where the new Stadler trains are running.	Develop revised design specifications incorporating design for reliability and avoiding single point of failure. Various Development of FFA-G wagons by Freightliner/Greenbrier Europe/Wabtec Axiom Rail – the FFA-G wagon is 2 tonnes lighter per platform and uses low track force bogies to help reduce track damage.	Use revised specifications when replacing assets. Various RIS-0703-CCS Issue 2 published by RSSB, to help suppliers and signalling layout designers to develop, design and implement lineside signalling systems that follow good practice.	Maintenance strategy and requirements are always specified at design stage as part of optimising whole-life cost. Key train and infrastructure requirements, or equivalents, set at an appropriate level of detail, system-level outputs and long-term asset strategy.
		Workforce and technologists co-create opportunities and co-design new way to exploit new technology for safety, reliability and value. Various East Midlands Railway project with the University of Sheffield will work with operational staff to build a representational model of the Nottingham Eastcroft depot which will form the basis of a virtual depot simulation tool, to plan and stress test operational scenarios.		Pilot co-designed operating concepts and systems.	
		Identify priority retrofit solutions to deliver a step-change through asset upgrades. GTR's first C387/1 Great Northern Electrostar train has been retrofitted with Alstom ETCS in-cab signalling as part of the East Coast Digital programme. Dynamic testing at NR's Rail Innovation Development Centre will complete by the end of 2023.	Develop tools to plan and assess the case for transitions to step-change performance of assets. Various Vehicle/Track Interaction Strategic Model (VTISM) updated by RSSB to provide improved modelling capabilities for vehicle/track interactions and long term asset maintenance/renewal planning	Apply the tools to inform industry planning.	

MOBILE ASSETS – FIXED ASSETS – BOTH MOBILE & FIXED   Suggested industry-level owners are underlined.   CCS – Control Command and Signalling   CP7 – Control Period 7   DRACAS – Defect Reporting Analysis and Corrective Action System   ETCS - European Train Control System
NR – Network Rail   ORR – Office of Rail and Road

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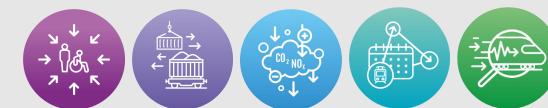
Good exploitation of data underpins all the other priorities of the Rail Technical Strategy. It is the key enabler to many of the important and necessary goals that the future railway needs to achieve.

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

Rail Technical Strategy

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.

Rail Technical Strategy
Innovating across Britain's railway

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**

Rail Technical Strategy

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.

Engage with the RTS

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

RTS Innovating across Britain's railway