



# Rail Technical Strategy

Innovating across Britain's railway

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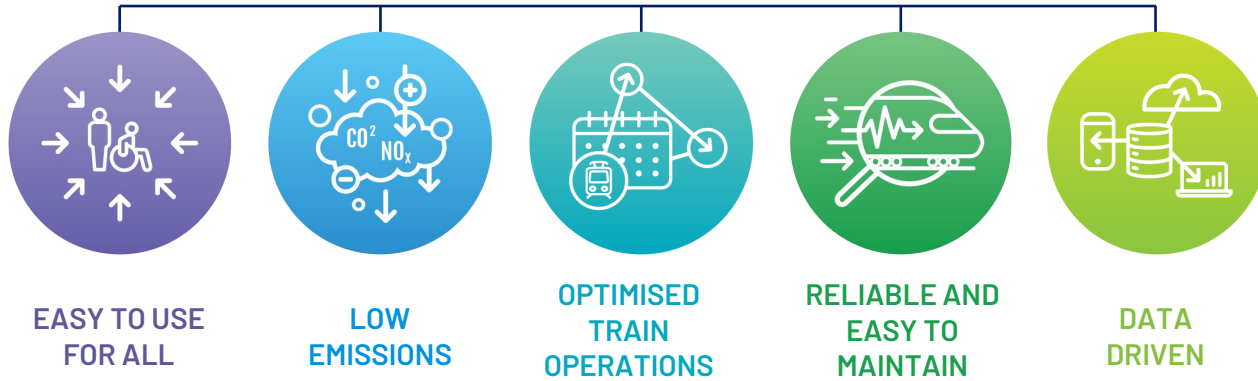


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# Rail Technical Strategy

## Innovating across Britain's railway

### FUNCTIONAL PRIORITIES



### DESIRED OUTCOMES

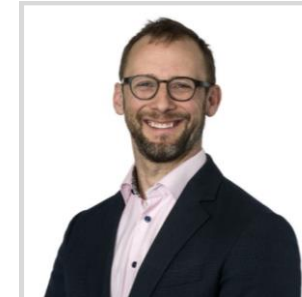


### CRITICAL ENABLERS



**Andrew Haines**  
Chief Executive  
Network Rail

*"This RTS is a major shift, outlining how we are making a step change in innovation across the rail sector. Let's embrace this strategy and build on this platform for change."*



**Paul Plummer**  
Chief Executive  
Rail Delivery Group

*"We welcome this strategy and train operators will work together with industry partners to deliver against the RTS and innovate across Britain's railway now and for the future."*



**Darren Caplan**  
Chief Executive  
Railway Industry Association

*"A rail sector able to meet these challenges through innovation will provide greater benefits to rail users, export more around the globe, generate more investment and jobs, and attract even more talent."*

# About the RTS



### The Rail Technical Strategy (RTS):

- Sets a clear direction for the development and uptake of existing and new solutions, informing investment pipelines within industry
- Aligns thinking and action, globally promoting UK's world-class rail expertise
- Stimulates supply chain to invest in innovative solutions in the most important areas
- Guides the prioritisation of existing research and innovation funds

### This edition was developed around the following principles:



**More focused** bringing clarity on agreed key problems, opportunities and solutions



**More compelling** setting out short-term steps needed in context of longer-term vision



**Less R&D centric** putting equal emphasis on challenges and opportunities around successful deployment and adoption

### Collaborative development

This edition was created collaboratively by a working group comprising representatives from RSSB, Network Rail and both academic and industrial UKRRIN partners.

It was developed with wider industry engagement and support including more than 100 organisations and over 30 prominent cross-industry groups.

Steering was provided by the Executive Technology Leadership Group.

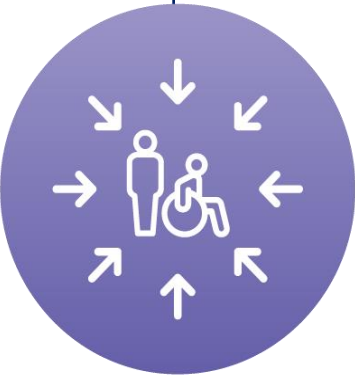
The working group would like to extend specific thanks to the Rail Delivery Group and Railway Industry Association for their ongoing support and input.

# Rail Technical Strategy

Innovating across Britain's railway

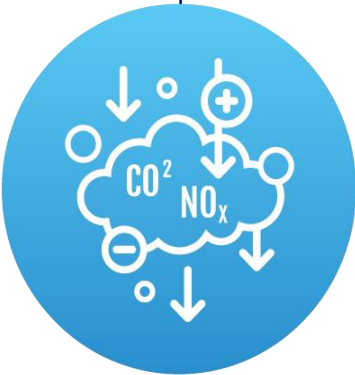
## FUNCTIONAL PRIORITIES

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.



### 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.



### DATA DRIVEN

Data, recognised as a highly valuable asset, will have fit for purpose governance, access arrangements, systems and technical skills. These building blocks underpin the progression of all the other functional priorities which each have their own specific data requirements and opportunities.





# 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

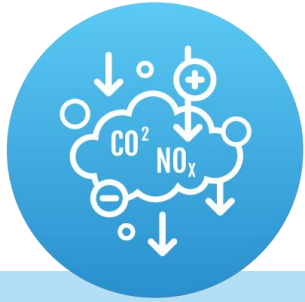
GOALS	WHY?	RECENT POSITION (2020)	STEPPING STONES IN THE NEXT FIVE YEARS			VISION FOR 2025	VISION FOR 2040
<b>Accurate, accessible and understandable real-time information</b>	Making it easier for passengers to plan and manage their journey reduces stress, exclusion and time lost, and increases confidence.	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.
<b>Smart fare collection</b>	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.
<b>Personalised services</b>	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.	Passenger centric measures of rail performance are identified and used.	Open data and AI enhance the level of customisation of support and services. 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.
<b>Accessible to all</b>	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.	
<b>Door to door solutions</b>	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.
<b>Reliable and fast on-board connectivity</b>	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
<b>Accurate, accessible and understandable real-time information</b>	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. <u>RDG</u> 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. <u>RDG</u> 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. <u>RSSB</u> 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. <u>RDG</u> 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.
<b>Smart fare collection</b>	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). <u>RDG</u> 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. <u>GBR</u> <u>DfT</u> & <u>RDG</u> 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. <u>DfT</u> & <u>RDG</u> 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. <u>GBRTT</u> Fares, Ticketing and Retail Review launched.	Open data and suitable commercial agreements deliver multi-modal ticketing provision. <u>RDG</u> 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.
<b>Personalised services</b>	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. <u>GBRTT</u> 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. <u>DfT</u> <u>GWR</u> 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. <u>Transport Focus</u> 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. <u>Suppliers</u> 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. <u>UKRRIN</u> 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.
<b>Accessible to all</b>	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. <u>NR</u> <u>CE</u> NaviLens, an app designed to help blind or partially-sighted customers navigate stations, trialled on DLR. <u>SWR</u> 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. <u>Various</u>	Account-based digital services make booking and providing assistance easier. <u>RDG</u> <u>ORR</u> 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). <u>GBRTT</u> 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.
<b>Door to door solutions</b>	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. <u>CPC</u> , <u>RDG</u> and <u>NR</u> 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. <u>RDG</u> & <u>NR</u> 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. <u>IBD</u> 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). <u>IBD</u> 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.
<b>Reliable and fast on-board connectivity</b>	Phone and mobile data coverage on trains is patchy and unreliable.	Lessons learnt from 5G trials inform technical and commercial plans. <u>NR</u> <u>SWR</u> and <u>NR</u> 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. <u>DfT</u> & <u>NR</u> 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. <u>Ofcom</u> 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.





# 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

GOALS	WHY?	RECENT POSITION (2020)	STEPPING STONES IN THE NEXT FIVE YEARS				VISION FOR 2025	VISION FOR 2040
<b>Cheaper and less disruptive electrification</b>	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.
<b>Zero-carbon self-powered vehicles</b>	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.	
<b>Low carbon freight</b>	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.	
<b>Increased energy efficiency</b>	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.	
<b>Reducing polluting emissions</b>	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

GOALS	RECENT POSITION (2020)	RECENT PROGRESS AGAINST STEPPING STONES		VISION FOR 2025		
<p><b>Cheaper and less disruptive electrification</b></p>	<p>Concerns over cost and disruption following recent electrification schemes have undermined political support.</p>	<p>Introduction of discontinuous electrification. <u>Various TfW</u> 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.</p>	<p>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. <u>NR &amp; RSSB</u>. 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.</p>	<p>Standards/incentives adopted to reduce the need for civil engineering while maintaining safety. <u>NR</u></p>	<p>Faster, more detailed and more effective planning and route clearance is enabled. <u>NR TDNS</u></p>	<p>New electrification schemes, including discontinuous electrification, are being developed to address cost and disruption challenges.</p>
<p><b>Zero-carbon self-powered vehicles</b></p>	<p>There are around 2,500 &lt;100mph diesel vehicles currently active, many of which run on lines unlikely to be electrified.</p>	<p>Standards for hydrogen and battery trains and associated infrastructure are adopted. <u>RSSB</u> 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.</p>	<p>Clear understanding of where electrification could provide tipping point for freight traction. <u>NR TDNS</u>. 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.</p>	<p>In-service fleet deployments for hydrogen- and battery-powered trains. <u>ROSCOs and academia</u> 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.</p>	<p>Energy-optimised timetable and real-time train speed profiles are enabled for off-peak operation. <u>NR and RSSB</u> T1263 has 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 identify the optimised options. T1270 will assess options to regulate the traction power demand on the Western Route.</p>	<p>Clear transitional and replacement arrangements for Sprinters (Classes 150-159) delivering zero carbon.</p>
<p><b>Low carbon freight</b></p>	<p>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.</p>	<p>Options, criteria and business case to retrofit traction options and alternative drop in fuels are developed. <u>ROSCOs and manufacturers</u> 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.</p>	<p>Clear understanding of where electrification could provide tipping point for freight traction. <u>NR TDNS</u>. 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.</p>	<p>Energy-optimised timetable and real-time train speed profiles are enabled for off-peak operation. <u>NR and RSSB</u> T1263 has 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 identify the optimised options. T1270 will assess options to regulate the traction power demand on the Western Route.</p>	<p>Energy-optimised timetable and real-time train speed profiles are enabled for off-peak operation. <u>NR and RSSB</u> T1263 has 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 identify the optimised options. T1270 will assess options to regulate the traction power demand on the Western Route.</p>	<p>Clear understanding of delivery roadmap and transition arrangements for low carbon freight.</p>
<p><b>Increased energy efficiency</b></p>	<p>The industry is neither incentivised nor aligned to improve the efficiency of rolling stock or infrastructure.</p>	<p>There is a strategy for reducing losses, especially on DC network as well as handling increased freight demand on the DC rail network. <u>NR</u> HS1 shared findings from a project that involved the introduction of regenerative braking technology introduced on Southeastern trains.</p>	<p>Clear and agreed technical requirements for rolling stock efficiency and emissions reduction, including retrofit, are adopted. <u>RSSB</u> 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 <u>RSSB</u> by September 2023.</p>	<p>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.</p>	<p>A programme of trials to test and compare mitigation options is delivered. <u>Various</u> 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. <u>NR</u> announced a trial of new purification devices at platforms 10 and 11 at Birmingham New Street.</p>	<p>Clear programme to reduce energy use is being delivered across the network.</p>
<p><b>Reducing polluting emissions</b></p>	<p>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.</p>	<p>Low-cost intelligent emissions monitoring and risk mapping is in place. <u>RSSB</u> A Stations Air Quality Monitoring Network (AQMN), developed and operated by <u>RSSB</u> 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.</p>	<p>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.</p>	<p>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.</p>	<p>A programme of trials to test and compare mitigation options is delivered. <u>Various</u> 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. <u>NR</u> announced a trial of new purification devices at platforms 10 and 11 at Birmingham New Street.</p>	<p>Air Quality Improvement Plans are in place and in action at locations where one is required.</p>



# 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

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.	Improved working timetable allocates allowances optimally, decreasing the risk of significant disruption if perturbations occur.	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.	
			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.		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	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.	Strong business case in place for widespread roll-out of TM based on positive results from early implementations.	Real-time optimisation of trains across the network together with effective prevention and recovery from disruptions.	
				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.	Reduction of variability in acceleration, braking and coasting on key route.		
				New data driven tools to prevent and help mitigate disruptions.		Define the capability gaps remaining to improved real-time operations and decisions during disruption.			Data insight used to inform real-time decisions and to prevent disruption.
				Trial and initial fitment of ETCS Limited Supervision on non-ETCS infrastructure.		SPAD risk is virtually eliminated, with positive impact on service reliability.			
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.	All lines have or are migrating to a digital signalling solution.		
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.	Open-source software infrastructure description	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.	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.	Trains can run closer together safely.	
				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.			Use of existing capacity is maximised
			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.	Predictable and reliable braking unaffected by railhead conditions.			





# Optimised train operations Progress against short-term vision

GOALS	RECENT POSITION (2020)	RECENT PROGRESS AGAINST STEPPING STONES			VISION FOR 2025		
<p><b>Flexible and reliable train planning</b></p>	<p>The timetabling process has a long lead time and the working timetable generated doesn't learn from actual running times.</p> <p>The 'short-term' and 'very short-term' planning processes are very manual and not robust.</p>	<p>Single common model of GB rail infrastructure used for all planning. <u>NR SO</u></p>	<p>Prioritised improvements of train planning data. <u>NR SO</u></p>	<p>Greater integration of crew and stock planning for long and short term planning. <u>RSSB</u> COF-G26 case study of Advanced Model Interface L3 of TM and Stock and Crew integration on ECML underway, due to complete 2024.</p>	<p>Solutions to allow the working timetable to learn from actual train performance. <u>NR SO</u></p>	<p>Improved working timetable allocates allowances optimally, decreasing the risk of significant disruption if perturbations occur.</p>	
<p><b>Improved real-time operations and decisions</b></p>	<p>Manual train handling leads to acceleration, braking and coasting lacking consistency.</p> <p>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.</p> <p>Richer data to better understand disruptions is starting to be explored.</p> <p>Incidents of Signals Passed at Danger remain a problem.</p>	<p>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. <u>NR SO, NR Target 190plus &amp; UKRRIN</u> NR Prior Information Notice for Target 190plus Synthetic Environment for the design and testing of signalling solutions published in July 2023.</p>	<p>Solutions available to increase flexibility and robustness of very short term planning. <u>RSSB</u> and <u>V/TC&amp;C SIC</u> 3Squard completed Solent Stevedores 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.</p>	<p>Train paths are added easily and reliably at short notice. Increased (predictable) quality of service during disturbances and faster recovery.</p>			
<p><b>Improved degraded operations</b></p>	<p>Degraded Mode Working System (DMWS) has been developed in the lab but not yet piloted.</p>	<p>Crew and rolling stock resources linked to traffic management (TM). <u>NR Projects</u> Western Route deployment of Integrale and Luminata, extended across Western Region and Anglia Route.</p>	<p>TM integration with signalling systems. <u>V/TC&amp;C SIC</u> Thameslink Class 700s to be upgraded following Class 387 testing, as part of the ECDP.</p>	<p>Wider roll-out of TM to support, and where appropriate, automate decisions in perturbation. <u>NR Regions</u> National TM Strategy exploring the range of options for deployment.</p>	<p>Widespread roll-out of C-DAS in conjunction with TM to improve passenger and freight performance. <u>RSSB, V/TC&amp;C SIC/DAS PCB</u> Class 387s running with C-DAS operational, Class 802 operations not yet commenced. C-DAS benefits paper from operational trial expected Autumn 23.</p>	<p>Strong business case in place for widespread roll-out of TM based on positive results from early implementations.</p>	
<p><b>Signalling and train capabilities support higher route capacity</b></p>	<p>Thameslink is successfully ramping up its capacity but traditional signalling and management of nodes continue to limit capacity on most of the network.</p> <p>The migration strategy to digital signalling is unclear.</p> <p>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.</p> <p>Reliable braking in low adhesion remains a challenge.</p>	<p>Open-source software infrastructure description. <u>NR</u> Project Axiom East Coast pilot underway (includes track, platform, S&amp;C, signals and track circuit data). Proofs of concept include geospatial viewer, gradient data, data interoperability and automated schematics.</p>	<p>New data driven tools to prevent and help mitigate disruptions. <u>RSSB, RDG, NR and TOCs</u> NR Seasons Team is looking at the Seasonal Agnostic Railway Model and assessing the impact of asset failures.</p>	<p>Define the capability gaps remaining to improved real-time operations and decisions during disruption. <u>TBD</u> 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.</p>	<p>Trial and initial fitment of ETCS Limited Supervision on non-ETCS infrastructure. <u>V/TC&amp;C SIC/TPSG</u> 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.</p>	<p>Agreed strategic deployment plan for driving task support systems to maximise value for money. <u>NR Projects</u></p>	<p>Reduction of variability in acceleration, braking and coasting on key routes.</p>
<p><b>Signalling and train capabilities support higher route capacity</b></p>	<p>Thameslink is successfully ramping up its capacity but traditional signalling and management of nodes continue to limit capacity on most of the network.</p> <p>The migration strategy to digital signalling is unclear.</p> <p>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.</p> <p>Reliable braking in low adhesion remains a challenge.</p>	<p>Mainline trials of DMWS. <u>V/TC&amp;C SIC/DMWS</u> Plans for 'track-only' trial cancelled due to funding constraints.</p>	<p>Agreed migration strategy and roll-out plan for radio based ETCS with no lineside signalling. <u>V/TC&amp;C SIC/TPSG</u> ETCS pilot on Northern City Line (Moorgate-Finsbury Park complete and deployed. East Coast delivery programme continuing train and infrastructure fitment through 2024.</p>	<p>Lessons identified and implemented from Thameslink mainline ATO deployment over ETCS Level 2. <u>V/TC&amp;C SIC/TPSG</u> Included in the European ATO over ETCS (AoE) specifications, recently published in the updated CCS TSI. Learnings from DRACAS also available for AoE projects.</p>	<p>Optimised ETCS braking curves for freight. <u>V/TC&amp;C SIC/TPSG</u></p>	<p>Reduced disruption during signalling failures.</p>	
<p><b>Signalling and train capabilities support higher route capacity</b></p>	<p>Thameslink is successfully ramping up its capacity but traditional signalling and management of nodes continue to limit capacity on most of the network.</p> <p>The migration strategy to digital signalling is unclear.</p> <p>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.</p> <p>Reliable braking in low adhesion remains a challenge.</p>	<p>Validated freight train integrity devices. <u>RSSB, RFG</u> Findings from T1264 provided GB freight industry with an evaluation framework and shared evidence base for introduction of Digital Automatic Coupling.</p>	<p>Enhanced train position systems. <u>Various</u></p>	<p>Block lengths shortened and optimised by automated design for new schemes. <u>V/TC&amp;C SIC</u></p>	<p>Faster operating, inherently safe, point mechanisms piloted. <u>NR R&amp;D &amp; UKRRIN</u> IN2TRACK3 project on redesigning actuators and simulating interlocking &amp; actuators (based on REPOINT) due to complete end of 2023.</p>	<p>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.</p>	
<p><b>Signalling and train capabilities support higher route capacity</b></p>	<p>Thameslink is successfully ramping up its capacity but traditional signalling and management of nodes continue to limit capacity on most of the network.</p> <p>The migration strategy to digital signalling is unclear.</p> <p>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.</p> <p>Reliable braking in low adhesion remains a challenge.</p>	<p>Rationalisation of train classes and applicable speeds to create homogeneous operations. <u>OPG and TOM SC</u> 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.</p>	<p>Double variable rate sanders specified for new trains; prioritised retrofitting for existing trains <u>RDG</u> Fitments are underway with SWR n Class 158/9s, Northern Class 323s and Scotrail Class 170s.</p>	<p>Magnetic track brakes for all new, frequent stop trains. <u>ARG</u> Testing of new Stadler-built Nexus metro fleet has now started ahead of entering passenger service in phases from 2023 -2025 .</p>	<p>Fundamental review of operational principles for mixed-traffic. <u>TBD</u> 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.</p>	<p>Capacity in the process of being increased at key bottlenecks thanks to better design and solutions.</p> <p>Use of existing capacity is maximised.</p> <p>Predictable and reliable braking unaffected by railhead conditions.</p>	



# 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

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





# Reliable and easy to maintain Progress against short-term vision

GOALS	WHY?	RECENT PROGRESS AGAINST STEPPING STONES			VISION FOR 2025
<p><b>Improved reliability and availability of existing systems</b></p>	<p>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.</p> <p>Services should only be disrupted as a last resort when assets fail.</p> <p>Increasingly complex railway systems raise the likelihood of service disruption through faulty interactions of assets or sub-systems.</p> <p>Greater resilience needed to cope with system stresses including climate change.</p>	<p>Identify rolling stock and fixed assets to be prioritised for improved reliability and availability, based on their performance impact. <u>Various</u> Porterbook has opened a modern Asset Management Facility (AMF) at Long Marston Rail Innovation Centre, to support trialling and testing of innovative traction tech.</p> <p>NR and Arcadis pilot performance-based data analytics and technical insights model on 19km of Western Route.</p>	<p>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. <u>Various</u> First-of-a-Kind Reliable and Maintainable Assets Rail competition for high maturity demonstrations launched in June 2023.</p>	<p>For high-priority assets, pilot and roll-out improvements to the assets, their management, fault response and operating approaches that keep services running. <u>Various</u> 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.</p>	<p>System resilient to many localised failures.</p> <p>Improved reliability by designing refinements that have high performance impact.</p> <p>Improved availability by accommodating failures to in-service assets with 'smarter' operations.</p> <p>Knowledge is routinely applied to improve system reliability, with the workforce guided by data and maintainers engaged in design.</p>
<p><b>Safe and rapid inspection and repair</b></p>	<p>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.</p> <p>Lower risk to workforce and less disruption can be achieved by more automated inspection and repair methods, and decision support.</p>	<p>Identify which high-priority (cost and impact) rolling stock and fixed assets could best use RCM, aligned with available sensor and comms technology. <u>Various</u> 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.</p>	<p>Deploy RCM systems to high-priority assets and use the data to optimise inspection, servicing and replacement schedules based on asset conditions and performance. <u>Various</u> 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.</p>	<p>Develop and deploy RCM systems to more rolling stock and fixed assets. Evolve RCM algorithms to improve their prediction accuracy. <u>Various</u> 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.</p>	<p>Condition-based inspection and maintenance (optimised for practicability) is widely used, replacing periodic inspection and maintenance.</p> <p>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.</p>
<p><b>Step-change in reliability, availability and whole-life cost for new assets</b></p>	<p>Future railway systems are designed to minimise single points of failure and deliver reliable service including under future climatic conditions.</p> <p>Upgrades of rolling stock and fixed assets are affordable and can deliver lower operating costs and a higher performing railway.</p> <p>Opportunity to create high-value, safe roles for our workforce, designed to exploit new asset capability.</p>	<p>Incorporate targets for Mean Time To Repair and Between Failures and ease of repair in asset specifications and sub-systems. <u>Various</u> New Greater Anglia/Stadler FLIRT bi-mode fleets achieving punctuality figures between 93% and 99% on routes where the new Stadler trains are running.</p>	<p>Develop revised design specifications incorporating design for reliability and avoiding single point of failure. <u>Various</u> 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.</p>	<p>Use revised specifications when replacing assets. <u>Various</u> 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.</p>	<p>Maintenance strategy and requirements are always specified at design stage as part of optimising whole-life cost.</p> <p>Key train and infrastructure requirements, or equivalents, set at an appropriate level of detail, system-level outputs and long-term asset strategy.</p>
		<p>Agree with industry and ORR the economic and safety case for condition-based inspection and maintenance. <u>IBD</u> There is currently no clear mechanism to support the coordination necessary to understand the case and support transition from periodicities.</p>	<p>Identify assets suitable for robotic and Artificial Intelligence (AI) inspection and maintenance. <u>Various</u> 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.</p>	<p>Demonstrate robotic and AI inspections in live environments with remote supervision from the workforce. Prove initial robotic and AI repair concepts. <u>Various</u> One Big Circle's AIVR technology will be used in a NR pilot to monitor low adhesion in Wales during Autumn 2023.</p>	<p>Roll out of robotics and AI inspection. Demonstrate robotic and AI repair solutions in live environments. <u>Various</u> AAR Rail demonstrated its Automated Discrete Repair machine to NR in January 2023, with an in situ low pre-heat weld restoration process.</p>
		<p>Workforce and technologists co-create opportunities and co-design new way to exploit new technology for safety, reliability and value. <u>Various</u> 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.</p>	<p>Develop tools to plan and assess the case for transitions to step-change performance of assets. <u>Various</u> 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</p>	<p>Pilot co-designed operating concepts and systems.</p>	<p>Apply the tools to inform industry planning.</p>



# Data driven



**Data, recognised as a highly valuable asset, will have fit for purpose governance, access arrangements, systems and technical skills. These building blocks underpin the progression of all the other functional priorities which each have their own specific data requirements and opportunities.**

Overcoming the barriers to greater awareness and exploitation of the industry's data assets will unlock a multitude of new opportunities to better serve customers, drive efficiency and target further technological progress.

### Key goals

- Easy access and sharing of data, including real-time data
- Robust industry-wide data governance
- Clear business case for data sharing
- Tools and skills for better data exploitation



**Will Wilson**  
Chief Executive Officer  
Siemens Mobility Limited

*“This priority is at the very core of the Rail Technical Strategy, underpinning all its elements and essential for the success and competitiveness of the future railway system and offerings.”*





# Data driven

GOALS	WHY?	RECENT POSITION (2020)	STEPPING STONES IN THE NEXT FIVE YEARS				VISION FOR 2025	VISION FOR 2040
<p><b>Easy access and sharing of data, including real-time data</b></p>	<p>It is essential to improve business efficiency and effectiveness, recognised in government and industry policies.</p> <p>Timely data allows real-time system improvements and enhanced decision-making for railway customers.</p>	<p>A limited range of data is available through industry platforms/APIs.</p> <p>Most data sets are not available or accessible.</p> <p>A range of assets and other sources generate data in real time, but this capability is not widely exploited.</p>	<p>Create and facilitate data sharing mechanisms.</p>	<p>Agree levels of data-sharing and develop template data-sharing agreements.</p>	<p>Capability for multi-modal data-sharing</p>	<p>The combination of effective rail data-sharing mechanisms, and a growing pipeline of data sources makes it easier for business and innovators to understand and access rail data.</p> <p>Compatibility of rail data-sharing approaches enables multi-modal data exploitation.</p>	<p>Ambitious strategies on data accessibility and exploitation are being implemented. These have ensured that rail is recognised as a leading data driven industry that manages, shares and exploits data to the benefit of our customers, the industry, and wider society.</p>	
<p><b>Robust industry-wide data governance</b></p>	<p>It is an essential enabler for greater sharing of data and assurance of data quality.</p>	<p>Several organisations are developing, or have developed, information management frameworks.</p>	<p>Develop cross-industry metadata to be used in data cataloguing.</p>	<p>Determine strategy for data standards.</p>	<p>Development of new data standards.</p>	<p>Cross-industry data standards being produced and adopted.</p> <p>Rail Information Management Framework principles being met on cross-industry basis.</p>		
<p><b>Clear business case for data sharing</b></p>	<p>This is a key enabler for business across the industry to prioritise and justify making data available.</p>	<p>There is limited research focusing on quantifying the benefits of opening up data sources.</p> <p>Traceability capabilities exist but are not used by the industry.</p>	<p>Develop approach for identifying 'high value' rail data sets.</p>	<p>Development of strategy and routemap towards achieving an 'open by default' data-sharing vision</p>	<p>Implementation of routemap to 'open by default' data-sharing.</p>	<p>Ongoing development of business cases to enable increasing amounts of open or shareable data.</p>		
<p><b>Tools and skills for better data exploitation</b></p>	<p>Advanced data capabilities are essential for the railway to drive and be competitive and integrated with other modes.</p>	<p>Rail expertise exists for traditional analytics.</p> <p>Cross-industry competence in new approaches to data is limited.</p> <p>Industry is not always an informed buyer and user of 'big data' and 'smart data' solutions.</p>	<p>Identify skill gaps within industry.</p>	<p>Develop new capabilities and outputs related to data, including digital twins and advanced AI, so that data can be easily connected to create greater value.</p>	<p>Develop and implement (re)training, support and guidance.</p> <p>Focus digital twins, AI and other data analysis developments that underpin the other four functional priorities.</p>	<p>Strategy for ensuring a digitally talented workforce has been implemented.</p> <p>Digital twin capability is strong.</p> <p>Advanced AI techniques are widely available and being used.</p>		



# Data driven Progress against short-term vision

GOALS	RECENT POSITION (2020)	RECENT PROGRESS AGAINST STEPPING STONES		VISION FOR 2025	
<p><b>Easy access and sharing of data, including real-time data</b></p>	<p>A limited range of data is available through industry platforms/APIs. Most data sets are not available or accessible.</p> <p>A range of assets and other sources generate data in real time, but this capability is not widely exploited.</p>	<p><b>Create and facilitate data sharing mechanisms. <u>Rail Delivery Group (RDG)</u></b></p> <p>The Rail Data Marketplace (RDM) went live in July 2023 and is accessible via <a href="http://www.raildata.org">www.raildata.org</a>. The RDM project team continue to work with industry to embed the marketplace as the key means of sharing data.</p>	<p><b>Agree levels of data-sharing and develop template data-sharing agreements. <u>RDG</u></b></p> <p>The RDM provides a template contracts for different data-sharing agreements.</p> <p><b>Create and manage priority pipeline of data sets. <u>RDG</u></b></p> <p>The RDM project has created a data set pipeline, informed by user research and is liaising with industry to facilitate sharing of this data.</p>	<p><b>Capability for multi-modal data-sharing <u>RDG and DfT</u></b></p> <p>Ongoing coordination with DfT to enable compatibility of RDM with DfT 'Find Transport Data' national access point facility.</p>	<p>The combination of effective rail data-sharing mechanisms, and a growing pipeline of data sources makes it easier for business and innovators to understand and access rail data.</p> <p>Compatibility of rail data-sharing approaches enables multi-modal data exploitation.</p>
<p><b>Robust industry-wide data governance</b></p>	<p>Several organisations are developing, or have developed, information management frameworks.</p>	<p><b>Develop cross-industry metadata to be used in data cataloguing. <u>DISIC</u></b></p> <p>The initial metadata structure has been used within RDM. <u>RSSB</u> T1297 is exploring further metadata useful to providing confidence for data consumers use of data.</p>	<p><b>Determine strategy for data standards. <u>RSSB</u></b></p> <p>Establishment of a new Data, Systems &amp; Telematics Standards Committee (DST SC) in Sept 2022. <u>GBRTT</u> is in process of developing industry Data Strategy. <u>DfT</u> published the Transport Data Strategy (TDS) in March 2023.</p>	<p><b>Development of new data standards. <u>RSSB</u></b></p> <p>DST SC is establishing a pipeline of priority data areas for standardisation.</p>	<p>Cross-industry data standards being produced and adopted.</p> <p>Rail Information Management Framework principles being met on cross-industry basis.</p>
<p><b>Clear business case for data sharing</b></p>	<p>There is limited research focusing on quantifying the benefits of opening up data sources.</p> <p>Traceability capabilities exist but are not used by the industry.</p>	<p><b>Develop approach for identifying 'high value' rail data sets. <u>RSSB</u></b></p> <p>T1184 is creating a framework for valuing GB rail data, and has identified a six stage process to support the identification of high-value data sets.</p>	<p><b>Development of strategy and routemap towards achieving an 'open by default' data-sharing vision. <u>DfT</u></b></p> <p>The Transport Data Strategy identifies a central data team that will act as a focal point to challenge why data is not being made openly available, with a presumption of open by default. The team will engage with data owners to support greater openness.</p>	<p><b>Implementation of routemap to 'open by default' data-sharing. <u>GBRTT/RSSB/DfT</u></b></p> <p>RSSB has started initial thinking on an data interoperability framework that could support the prioritisation of datasets.</p> <p><b>Ongoing development of business cases to enable increasing amounts of open or shareable data.</b></p>	<p>Widespread ability to build cross-industry business cases for the sharing of data.</p> <p>Data is being shared at the right level of openness.</p> <p>High-value datasets are being made available.</p>
<p><b>Tools and skills for better data exploitation</b></p>	<p>Rail expertise exists for traditional analytics.</p> <p>Cross-industry competence in new approaches to data is limited.</p> <p>Industry is not always an informed buyer and user of 'big data' and 'smart data' solutions.</p>	<p><b>Identify skill gaps within industry. <u>NSAR</u></b></p> <p>NSAR is providing resources such as Skills ID and the Skills Intelligence Model that can be used to develop competency management systems and determines resourcing and skills requirements for the future.</p>	<p><b>Develop new capabilities and outputs related to data, including digital twins and advanced AI, so that data can be easily connected to create greater value. <u>DfT, NR, RSSB, Suppliers</u></b></p> <p>DfT has 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.</p> <p>A wide range of industry stakeholders continue to grow capability in data exploitation. The RTS 'Who is Doing What' spreadsheet details a selection.</p>	<p><b>Develop and implement (re)training, support and guidance. <u>NSAR</u></b></p> <p><b>Focus digital twins, AI and other data analysis developments that underpin the other four functional priorities. <u>Various</u></b></p>	<p>Strategy for ensuring a digitally talented workforce has been implemented.</p> <p>Digital twin capability is strong.</p> <p>Advanced AI techniques are widely available and being used.</p>



### BUSINESS DRIVEN INNOVATION

Collaborative research & innovation pulled by industry that leverages academic and supply chain expertise

### RAPID BENEFIT REALISATION

Streamlined, reliable and timely deployment of novel solutions driven by sound long-term planning

### DIGITALLY TALENTED WORKFORCE

A highly technologically literate and diverse workforce across the industry that advocates and embraces digital solutions

## 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, finding ways to accelerate successful take up of new technologies, and ensuring that the rail sector attracts and develops ample digital talent.



## DESIRED OUTCOMES

The railway exists to move people and goods from place to place in a safe and efficient manner. It also has a responsibility to contribute to protecting the environment and supporting wider society.



As technology advances these core outcomes need to be remembered, so that the maximum overall benefit is achieved.

The well-established 'Four C' challenges of reducing cost and carbon, increasing customer satisfaction and providing agile capacity remain pertinent and align with the outcomes targeted by the Rail Technical Strategy.

The four outcomes described here provide a framework in which the technical priorities established in this strategy should be considered.

# Engage with the RTS



Explore the full strategy including the live components at:

[www.RailTechnicalStrategy.co.uk](http://www.RailTechnicalStrategy.co.uk)

### **A live strategy for everyone to engage with**

Major progress within industry cannot be achieved by one party, but requires joined-up efforts from many players.

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 input from outside of rail.

This digital, living RTS aims to inform and complement evolving thinking.

### **Share the technical solutions you are developing and deploying**

We invite you all to let us know what you are working on to capture what wider industry is delivering or considering initiating in relationship to the five functional priorities.

We are also looking to expand the range of case studies featured in the RTS to help the railway celebrate and publicise technical successes. The aim is to help potential partners and customers find you and understand what is available whilst protecting your IPR.

### **Your feedback is welcome**

Individuals and organisations can add to the picture, and constructively challenge the direction of travel and its speed.

We are interested to know about new ideas and opportunities to accelerate towards the stated vision for 2040.

Get in touch at:

[rts@rssb.co.uk](mailto:rts@rssb.co.uk)



