Rail Technical Strategy

Innovating across Britain's railway

CONTENTS

Rail Technical Strategy

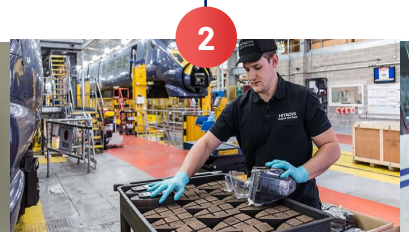
Innovating across Britain's railway

FUNCTIONAL **PRIORITIES**

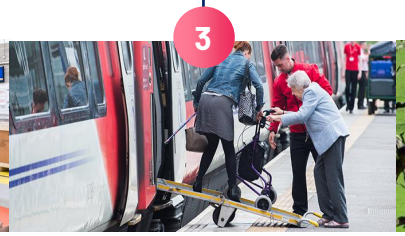
- EASY TO USE FOR ALL
- LOW EMISSIONS
- OPTIMISED TRAIN OPERATIONS
- RELIABLE AND EASY TO MAINTAIN
- DATA DRIVEN

DESIRED **OUTCOMES**

HAPPY CUSTOMERS



A VIBRANT SECTOR



STRONGER SOCIETY AND ECONOMY

BETTER ENVIRONMENT

CRITICAL **ENABLERS**

- BUSINESS DRIVEN INNOVATION
- RAPID BENEFIT REALISATION
- DIGITALLY TALENTED WORKFORCE

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

Rail Technical Strategy

Innovating across Britain's railway

FOREWORD

Paul Plummer

The railway has faced unprecedented challenges as a result of the Covid-19 pandemic. There has been much discussion as to the long-term impact the pandemic may have and in particular how it may affect people's travel patterns. It is impossible to know exactly what the future looks like for any mode of transport, but we know that the railway is facing a pivotal moment of reappraisal with the opportunity to build a better, greener and more customer-focused service fit for the digital age.

Before the pandemic, the railway was already in need of reform. A tired franchise model that stifles innovation and investment, a perceived lack of accountability and an overly complex fares and ticketing system that fails to meet the needs of today's customers – all evidence of a need to do things differently.

The Covid-19 pandemic has not reduced the need for change. As well as structural and regulatory reform, new and improved technical solutions will be critical, and the Rail Technical Strategy (RTS) sets a clear direction for their development.

Train operating companies' three decades of experience serving passengers is invaluable to secure customer-centric innovation, and a better railway will need to harness the experience and investment private sector operators can bring to the table. Coupled with bold reforms, train operators working with Network Rail and the supply chain are ready to deliver significant improvements for customers, taxpayers and the wider economy.

The RTS is a compelling blueprint developed and devised by senior industry representatives. It focuses and aligns the thinking of the industry's key players, bringing together the knowledge and expertise needed to accelerate towards building a railway fit for the future.

Today, 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.

Paul Plummer *Chief Executive*, Rail Delivery Group

Rail Technical Strategy

Innovating across Britain's railway

FOREWORD

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

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 new edition has been developed with the following principles in mind:

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

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

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

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

About the RTS

RTS Working Group

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

RAIL SAFETY AND STANDARDS BOARD

NetworkRail

UKRRIN
UK RAIL RESEARCH AND INNOVATION NETWORK

You can get in touch with the working group at rts@rssb.co.uk

Governance and acknowledgements

This edition of the RTS has been developed with wider industry engagement and support including more than 100 organisations and over 30 prominent cross-industry groups including Planning Oversight Group, the Industry Decarbonisation Task Force, each of the seven Systems Interface Committees, Customer Experience Forum, and many more.

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 Delivery Group

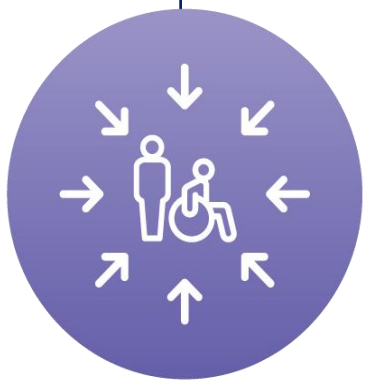
National Rail

Railway Industry Association

The voice of the UK rail supply community

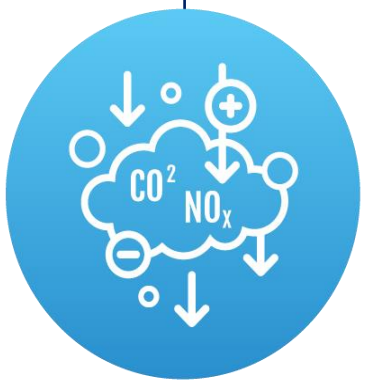
FUNCTIONAL **PRIORITIES**

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

Anthony Smith
Chief Executive
Transport Focus

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

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

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

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

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

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

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

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

Easy to use for all

RTS Innovating across Britain's railway

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). Smart ticketing on mobile devices to improve reservation and personalisation for less frequent, longer, more expensive journeys. Account-based ticketing underpins the Digital Fares and Ticketing Platform to allow simplification and personalisation. 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. Open data and AI enhance the level of customisation of support and services. (Specific) real-time passenger feedback is proactively sought and made easy to provide. Passenger centric measures of rail performance are identified and used. New design solutions on trains make on-board tasks and activities easier and more pleasant.	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). Assess new solutions to remove hazards and barriers for people with reduced mobility (e.g. gateless access and crowding control). Roll out tools for people with less visible disabilities to use the railway. Account-based digital services make booking and providing assistance easier. Inclusive design tools and measures to assess and cater for all capability losses are developed and used to inform stretching inclusion targets.	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. Develop operational concepts and facilities for connections with emerging modes (including micro-mobility). Data exchange in place to allow better connection decisions by transport operators and the travelling public. Feasibility studies on tools to optimise passenger flow within and across modes.	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

RTS Innovating across Britain's railway

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 GBR TT's response report on the call for evidence into WISP captured key customer experience challenges. Improvements to on-train announcements in delivery. **Personalised information sent to customers based on their journey and travelling patterns.** RDG Smarter Information Programme roadmap sets out capabilities required to deliver the ultimate customer information experience to support GBR TT planning. **Development of biosafety indicators that support customers and industry decisions.** RSSB A dedicated pandemic response and public health role has been established as part of the Leading Health & Safety on Britain's Railway (LHSBR) programme. **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 NR trial of Whoosh Real-Time Journey Dashboard (RTJD) app at key stations.	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 TfL rolling out contactless PAYG journeys in/out of London, similar schemes being rolled out on GWR, SWR and Transport for the North. **Smart ticketing on mobile devices to improve reservation and personalisation for less frequent, longer, more expensive journeys.** DfT & RDG Flexible smart ticketing platform in development for all ITSO accredited smart ticket products, transactions and passenger journeys. **Account-based ticketing underpins the Digital Fares and Ticketing Platform to allow simplification and personalisation.** GBR DfT & RDG Unicard's cloud-hosted Host or Operator Processing System (HOPS) system selected to deliver smart ticketing across multiple TOCs. **Digital Fares and Ticketing Platform enables richer services to passengers and third parties.** RDG **Open data and suitable commercial agreements deliver multi-modal ticketing provision.** RDG Unicard smart ticketing platform includes functionality to support future multi-modal ticketing.	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.** Rail Data Council RDC is leading work on this area, as part of the RTS Data Driven functional priority. **Open data and AI enhance the level of customisation of support and services.** Suppliers Introduction of EMR/Zipabout SMS alert service. TRIG funding for Wordnerds' 'night watchman' social media analysis. **(Specific) real-time passenger feedback is proactively sought and made easy to provide.** DfT Refresh of Wavelength survey, Whoosh RTJD and sentiment analysis pilots underway. **Passenger centric measures of rail performance are identified and used.** Transport Focus 'Transforming Rail Travel' report published February 2022 sets out recommendations for GBR. **New design solutions on trains make on-board tasks and activities easier and more pleasant.** UKRRIN UCL's immersive passenger environment has joined UKRRIN. Huddersfield IRR has launched a high-fidelity train motion simulator.	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).** Disabled Persons Transport Advisory Committee (DPTAC) reference frame: working towards a fully accessible railway published in February 2022. **Assess new solutions to remove hazards and barriers for people with reduced mobility (e.g. gateless access and crowding control).** NR CE WISP to include development of activities to improve accessibility at key stations. **Roll out tools for people with less visible disabilities to use the railway.** NR CE WISP is developing an overarching accessibility strategy, to include those with less visible disabilities. **Account-based digital services make booking and providing assistance easier.** RDG Passenger Assist requests now available from two hours before travel. Three-year roadmap for Passenger Assist programme supported with funding for the next phase of development. **Inclusive design tools and measures to assess and cater for all capability losses are developed and used to inform stretching inclusion targets.** University of Cambridge An Exclusion Calculator has been produced and used by Siemens and Hitachi. Further work is needed to update this information and a plan to keep it maintained.	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 The Smart Infrastructure & Mobility Urban Lab and Test Environment (SIMULATE) in Staffordshire completed, having explored tech (e.g. pop-up EV chargers and electric scooters) to show how the transport hub of the future could look and function. **Develop operational concepts and facilities for connections with emerging modes (including micro-mobility).** TBD **Data exchange in place to allow better connection decisions by transport operators and the travelling public.** RDG & NR Uber has announced plans to enable intercity rail, coach, car rental and flight bookings to support a door-to-door experience. **Feasibility studies on tools to optimise passenger flow within and across modes.** TBD Network Rail used RateSetter+ to inform the development of its business case for station enhancements to improve passenger flow at Peckham Rye.	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 5G testbed established at RIDC Melton. South Western Railway installation between Earlsfield and Basingstoke underway, expected to go live for customers by Spring 2023. **Agreed overall plan to improve rail connectivity starts to be delivered.** DfT & NR BAI network expanding and improving coverage for TfL. HS2 plan in development to support seamless connectivity. **Regular reports on the extent and quality of mobile coverage on the railways are in place.** Ofcom A discussion paper called for inputs to inform Ofcom's strategy to support the development of mobile markets, including rail.	Good on-board voice and data connectivity is a given when travelling by rail.

Suggested industry-level owners are underlined. NR – Network Rail CE – Customer Experience Team UKRRIN – UK Rail Research & Innovation GBR – Great British Railways PTI Group – Platform Train Interface Group CPC – Connected Places Catapult GBR TT – Great British Railways Transition Team WISP – Whole Industry Strategic Plan RDG – Rail Delivery Group IRR – Institute of Railway Research (University of Huddersfield) RIDC – Rail Innovation & Development Centre (RIDC)

v2.1

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.

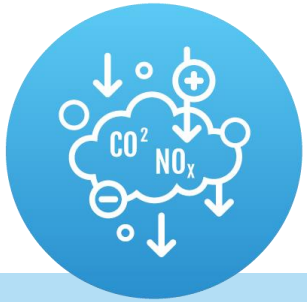
Better air quality is key to the health of our passengers, staff and wider society. A fully decarbonised and energy efficient railway will ensure that the sector plays a key role in meeting net zero carbon ambitions for the transport sector.

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.

Low emissions

RTS Innovating across Britain's railway

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 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.	Robust mitigation is in place, based on risks.	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 are partially electrifying the Core Valley Lines with rolling stock powered by a combination of overhead line and on-board battery power. Transport Scotland are also undertaking 'partial electrification' of the Fife route as an interim passenger decarbonisation solution.	**Rail has a clear power-supply strategy, including lineside storage, distributed generation, onboard and hydrogen. This takes account smart grid, storage and load balancing opportunities.** NR & RSSB NR has looked at some aspects of this challenge. T1272 will look at elements of this including charging battery electric bi-mode trains while running on the electrified network. T1229 is looking, in part, at areas of power supply constraint across the electrified network with regard to power demands for freight trains and is due to complete in autumn.	**Standards/incentives adopted to reduce the need for civil engineering while maintaining safety.** NR In-service trials of insulated pantograph horns with GWR underway (due to complete March 2023).	**Faster, more detailed and more effective planning and route clearance is enabled.** NR TDNS DfT planning a rail decarbonisation programme with GBRTT. Future developments of alternative traction technologies will continue to be monitored as technological advances progress.	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 A project on risks associated with hydrogen, which will inform standards revisions is being scheduled alongside engagement on policy implications. T1185, a key enabler to the operation of bi-mode trains in terms of on-network charging, has been published.		**In-service fleet deployments for hydrogen- and battery-powered trains.** ROSCOs and academia The MultiHyFuel project (COF-MHY) is underway. Initial experimental work and modelling has been presented to stakeholders from the rail and energy sectors. Testing on a purpose-built rig is now underway. GWR and Vivarail trial of battery train and fast-charging technology on the Greenford branch line to begin during 2022.		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 Findings from T1229, on energy and power demands for indicative freight routes, will help determine design requirements for low carbon freight traction	**Clear understanding of where electrification could provide tipping point for freight traction.** NR TDNS Two projects are due to inform thinking in this area. An aspect of T1263, which is due to complete at the end of the year, is exploring opportunities to increase freight services where passenger services have been thinned out. T1214, which focusses on determining the feasibility of improving efficiency and safety of DC electrification system for infill in existing network, has been completed and published.		**Energy-optimised timetable and real-time train speed profiles are enabled for off-peak operation.** NR In January 2022 DfT directed five arms-length bodies including NR to implement PAS2080 Carbon Management in Infrastructure as part of an effort to accelerate reduction of embedded carbon. RSSB T1263 is developing a framework for freight-prioritised, low emissions pathing and regulation decisions. It is considering holistic impacts of whole network traffic to identity the optimised options and is expected to complete by the end of the year.	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 are currently exploring options. RSSB Project T1214 looked at infill options on the DC network and is now complete, with the publication including a decision support workbook and user guide.	**Clear and agreed technical requirements for rolling stock efficiency and emissions reduction, including retrofit, are adopted.** T1233 'Air Quality Targets' provided interim recommendations for AQ targets which are currently being finalised and expected to be confirmed early 2023. The analysis includes modelling work to assess likely AQ and emissions improvements over time. The GBR Rolling Stock pathways are being considered as part of this process. T1236 'Rail emissions mitigation' identified potential incentivisation schemes, set out a new method to appraise air quality impacts from railways using the existing T1186 mapping tool, assessed the costs and benefits of mitigation measures for a selection of passenger and freight services, and delivered a financial model to determine the level of incentivisation required to develop viable business cases around air pollution mitigation measures. SUS-2022-012 'Industry Idling Reduction Initiative' aims to deliver tangible reductions in engine idling with best practice guidance on how this can be maintained and repeated across industry.		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 currently has limited understanding of the scale, location and risk of emissions.	**Low-cost intelligent emissions monitoring and risk mapping is in place.** RSSB, DfT and NR Diffusion tube monitoring has been set up at over 100 stations as part of the Air Quality Monitoring Network, funded by DfT. Installation of reference monitors is underway at selected sites, including Birmingham New Street. Trials of low-cost sensors are underway, with a view to a wider rollout.		**A programme of trials to test and compare mitigation options is delivered.** RSSB T1235 'Performance requirements and testing protocols for emissions mitigations' has been completed with the methodology and protocol now published. Supporting material is available to aid set up of testing and calculation of results		Robust mitigation is in place, based on risks.

Suggested industry-level owners are underlined. NR – Network Rail TDNS – Traction Decarbonisation Network Strategy GBR TT – Great British Railways Transition Team

v2.1

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.

Optimised train operations

RTS Innovating across Britain's railway

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.
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.	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.

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Optimised train operations
Progress against short-term vision

RTS Innovating across Britain's railway

GOALS	RECENT POSITION (2020)	RECENT PROGRESS AGAINST STEPPING STONES	VISION FOR 2025
Flexible and reliable train planning	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.** NR SO Project Axiom established to implement the approach developed in the Network Model pilot. **Prioritised improvements of train planning data.** NR SO Better Data for Better Operations business case in development and ITTS data workstream. **Greater integration of crew and stock planning for long and short term planning.** TBD Included in ITTS modelling timetable assessment. **Solutions to allow the working timetable to learn from actual train performance.** NR SO Plan being developed under ITTS operational feedback workstream. **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 synthetic environment proof of concept underway. HS2 'predict and prevent' digital twin in development. Hitachi NCX Panel simulation used to train signallers. **Solutions available to increase flexibility and robustness of very short term planning.** RSSB and V/TC&C SIC 3Squared secured funding for the next phase of development for PathPlanner, Worldline is developing the roadmap for commercialising PathFinder. The Bellvedi/Tracsis Assisted VSTP solution is at demo stage.	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	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. NR NR is developing the State of Railway Compiler (SoRC), which aims to capture the state of the signalling system and status of trains running on it, in a clear and consistent way, to inform better predictions. **Crew and rolling stock resources linked to traffic management (TM).** NR Projects Pilot on the Western Route launched in Nov 21, integrating Integrale and Luminate. **TM integration with signalling systems.** V/TC&C SIC Anglia interfaced TM system deployed. **Wider roll-out of TM to support, and where appropriate, automate decisions in perturbation.** NR Regions Arriva Rail London planning to use TM to amend services in times of disruption. **Widespread roll-out of C-DAS in conjunction with TM to improve passenger and freight performance.** RSSB, V/TC&C SIC/DAS PCB C-DAS pilot underway offering live info to Hitachi Class 387 and 802 drivers on the Western Route. **Elements of ATO-ETCS piloted to remove variability in driving profiles.** V/TC&C SIC Piloted and is currently in use on Thameslink Core. **Agreed strategic deployment plan for driving task support systems to maximise value for money.** NR Projects To be informed by the trial on the Western Route which is using existing TMS, junction optimisation tool and new Hitachi rolling stock capabilities. **New data driven tools to prevent and help mitigate disruptions.** RSSB, RDG, NR and TOCs NR North East Route launched a SI procurement to develop and embed a new approach to external disruption. **Define the capability gaps remaining to improved real-time operations and decisions during disruption.** TBD Following implementation project (IMP-T1154), RSSB is working with Network Rail to support industry to fully adopt the toolkit and its processes. **Trial and initial fitment of ETCS Limited Supervision on non-ETCS infrastructure.** V/TC&C SIC/TPSG Thales Radio Based Limited Supervision trial on Porterbrook Class 150/2 underway. Class 150 fitted for trials in West Somerset.	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	Degraded Mode Working System (DMWS) has been developed in the lab but not yet piloted.	**Mainline trials of DMWS.** V/TC&C SIC/DMWS Westbury operational 'track-only' trial with Siemens now planned for July 2023. **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	Reduced disruption during signalling failures.
Signalling and train capabilities support higher route capacity	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.** V/TC&C SIC/TPSG Ongoing work on Long-Term Deployment Plan. ETCS Pilot on Northern city line started in June 2022, East Coast deployment plan delivering in 2024 onwards. **Lessons identified and implemented from Thameslink mainline ATO deployment over ETCS Level 2.** V/TC&C SIC/TPSG **Optimised ETCS braking curves for freight.** V/TC&C SIC/TPSG Review of Safety of National Braking Curves for freight trains, consultation doc released March 2021. **Validated freight train integrity devices.** RSSB, RFG T1264 findings and cost benefit assessment completed, to inform introduction of Digital Automatic Coupling. **Enhanced train position systems.** Various Thales is piloting its Robust Train Positioning System onboard an in-service GWR Class 150 cab. **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 Work on redesigning actuators and simulating interlocking & actuators (based on REPOINT) to progress to IN2TRACK 3. **Rationalisation of train classes and applicable speeds to create homogeneous operations.** OPG and TOM SC T1266 will assess 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. **Fundamental review of operational principles for mixed-traffic.** TBD T1263 Guidance for efficient and low emission freight path and regulation policies is underway. **Double variable rate sanders specified for new trains; prioritised retrofitting for existing trains** RDG Work is now underway to retrofit DVRS on all Northern units in the class 323 fleet. SWR funding secured for Class 15X fleet. **Magnetic track brakes for all new, frequent stop trains.** ARG Fitment to new Stadler-built Nexus metro fleet entering service in 2023, full fleet intro 2024. **Train doors and interior layouts optimised during overhaul and for new build to minimise dwell time.** RSSB T1257 on more efficient guard controlled door operation, and T1262 on driver controlled door operation, are both underway.	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. NR – Network Rail SO – Systems Operator UKRRIN – UK Rail Research & Innovation Network V/TC&C SIC – Vehicle/Train Control & Communications Systems Interface Committee DAS PCB – Driver Advisory Systems Board RFG – Rail Freight Group DMWS TPSG – Degraded Mode Working Systems TPSG – Train Protection Strategy Group OPG – Operational Rules and Principles Group TOM SC – Traffic Operations Management Standards Committee ARG – Adhesion Research Group ITTS – Industry Timetable Technical Strategy RDG – Rail Delivery Group

v2.1

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 and 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.

Reliable and easy to maintain

RTS Innovating across Britain's railway

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. 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.	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.
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. 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.	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.
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. 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.	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.

Reliable and easy to maintain
Progress against short-term vision

RTS Innovating across Britain's railway

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 Fitment of Hitachi's full-suite digital maintenance solution on GWR's high speed intercity fleet, monitoring gearboxes, traction motors, bearings and wheels in real-time. Launch of FOAK 2022 competition on solutions for cost efficiency and performance priorities for a reliable railway.	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 Network Rail's Third Adaptation Report published in December 2021 setting out priorities for climate adaptation.	For high-priority assets, pilot and roll-out improvements to the assets, their management, fault response and operating approaches that keep services running. Various Pilot with British Transport Police to test the use of drones for line searches without stopping trains. The University of Sheffield's cryogenic track cleaning system, Cryogrip, was successfully trialled with Northern and NEXUS Tyne & Wear Metro.	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 Defect Reporting Analysis and Corrective Action System (DRACAS) model developed by RSSB, with an update to RIS-0707-CCS planned for 2023.	Pilot cross-industry reporting system to prove its benefits in managing complex faults. Various ETCS DRACAS pilot on East Coast Mainline underway, full implementation expected in 2024, with findings expected to inform plans for wider implementation.	Increase the range of assets covered by this reporting system and feed enhanced system-level requirements into design specifications. Various Ongoing work by the System Authority Assurance Team to update the suite of assurance documents for ETCS.	
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 HS2 digital twin in development to support the use of Artificial Intelligence for monitoring asset performance trends across the network.	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 A FOAK project, OptRail-PRO, is using Integrated Optical Fibre Sensing, to monitor switches and crossings, and another is using thermal radiometry camera technology to measure temperatures of mechanical systems onboard trains.	Develop and deploy RCM systems to more rolling stock and fixed assets. Evolve RCM algorithms to improve their prediction accuracy. Various A FOAK project led by Hitachi-Perpetuum is focussed on train axle crack monitoring to reduce returns to depot by using sensors and pattern-recognition technologies to monitor for cracks in train axles.	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	Demonstrate robotic and AI inspections in live environments with remote supervision from the workforce. Prove initial robotic and AI repair concepts. Various Arup and NR High Speed have developed an automated solution for tunnel inspections.	Roll out of robotics and AI inspection. Demonstrate robotic and AI repair solutions in live environments. Various Porterbrook and ScotRail trial of Hitachi-Perpetuum real-time digital solution to monitor and predict track maintenance launched in March 2022.	
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.	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.
		Workforce and technologists co-create opportunities and co-design new way to exploit new technology for safety, reliability and value. Various		Pilot co-designed operating concepts and systems.	
		Identify priority retrofit solutions to deliver a step-change through asset upgrades. ETCS has been retrofitted to Class 43 and 180 trains. Hitachi Rail and Angel Trains agreed to retrofit TransPennine Express intercity diesel trains with batteries to create electric-diesel-battery hybrid.	Develop tools to plan and assess the case for transitions to step-change performance of assets.	Apply the tools to inform industry planning.	

MOBILE ASSETS – FIXED ASSETS – BOTH MOBILE & FIXED

Suggested industry-level owners are underlined. GWR – Great Western Railway NR – Network Rail UoH (IRR) – University of Huddersfield (Institute of Railway Research) FOAK – UK Research & Innovation First-of-a-Kind competition ETCS - European Train Control System DRACAS – Defect Reporting Analysis and Corrective Action System

v2.1

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

Will Wilson
Chief Executive Officer
Siemens Mobility Limited

Data is the rail industry's primary growing asset: the amount and speed of data being generated by running the railway is growing at a very steep trajectory thanks to increasing digitalisation. But can we say the same for our collective ability as a sector to access and exploit it, with the ultimate aim to make better informed decisions?

Many studies have shown that when businesses have better access to data and have the capabilities to exploit it, new ideas emerge faster, and can be translated into successful products and improvements more easily and successfully. More than ever before, access and clever use of data underpins the success of any company or sector.

So, this priority is far from standalone. I see it 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.

If we fail to make substantial and speedy progress with this, all other priorities are compromised: data is key to enabling the provision of greater and better information to customers; it is essential to target improvements in reducing emission; and it is at the very core of the optimisation of railway operations and real-time proactive asset management.

Every time I speak with our research and innovator partners, it is clear that we could be doing so much more in rail to use data in creative and novel ways to drive innovation and respond to customer needs. So what are the challenges to overcome?

A key one is how we successfully increase data openness, so that researchers, innovators and more generally all those working in rail can have a much better understanding of this growing asset and how to access it. One of the challenges to releasing the benefits of data arises from its dispersed ownership within industry, and underpinning contractual relationships. This is particularly true when those getting value from the data are not those bearing the cost of collecting it and enabling access to it.

Innovative data-sharing partnerships and mechanisms may be necessary to leverage all the benefits of 'Big Data', without forgetting smaller and easier incremental progress such as 'access points' and availability of data samples.

Having confidence in the cross-industry and wider societal advantages of data-sharing, and collaboratively working towards enabling them to happen, are crucial. This can only occur if we collectively develop a much better understanding than we currently have of the size of prize to be gained by improved data access and sharing at the societal, industry and individual company level. An approach based on the demonstration of benefit, using priority use cases can both help clear the obstacles and light the way.

A further challenge is the lack of harmonised governance on data quality, metadata and data characteristics that would make integration, aggregation and fusion easier.

A strong cross-industry approach will also be necessary to deal with the undoubted cyber-security issues that will accompany a greater use of and reliance on data. There have been several recent examples of cyber security breaches significantly affecting organisations' ability to function and incurring reputational damage. Data dependence must go hand-in-hand with watertight data protection.

And we should not forget the foundational skills required for this. This can be a win-win for rail and its workforce, allowing the sectors to develop the capabilities needed and enabling individuals access to professional development and life-long learning opportunities that make their jobs more fulfilling today and prepares them for tomorrow's needs.

The industry is making strides in these areas through the work of Rail Data Council, which is leading progress against the data pillar of the Rail Sector Deal, and many other initiatives. The journey we need to make requires the whole industry to be behind the imperative of a data-driven railway, and work together to overcome the barriers and challenges to its achievement.

Data driven

RTS Innovating across Britain's railway

GOALS	WHY?	RECENT POSITION (2020)	STEPPING STONES IN THE NEXT FIVE YEARS	VISION FOR 2025	VISION FOR 2040
Easy access and sharing of data, including real-time data	It is essential to improve business efficiency and effectiveness, recognised in government and industry policies. Timely data allows real-time system improvements and enhanced decision-making for railway customers.	A limited range of data is available through industry platforms/APIs. Most data sets are not available or accessible. A range of assets and other sources generate data in real time, but this capability is not widely exploited.	Create and facilitate data-sharing mechanisms. Agree levels of data-sharing and develop template data-sharing agreements. Capability for multi-modal data-sharing Establishment of GBR Digital Data Service. Create and manage priority pipeline of data sets.	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. Compatibility of rail data-sharing approaches enables multi-modal data exploitation.	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.
Robust industry-wide data governance	It is an essential enabler for greater sharing of data and assurance of data quality.	Several organisations are developing, or have developed, information management frameworks.	Agree a cross-industry information management framework (IMF), including cyber-security issues. Cross-mapping of IMF principles to industry initiatives and activities. Ensuring all IMF principles are sufficiently addressed within rail ecosystem. Develop cross-industry metadata to be used in data cataloguing. Determine strategy for data standards. Implementation of data standards routemap.	Cross-industry data standards being produced and adopted. Rail Information Management Framework principles being met on cross-industry basis.	
Clear business case for data sharing	This is a key enabler for business across the industry to prioritise and justify making data available.	There is limited research focusing on quantifying the benefits of opening up data sources. Traceability capabilities exist but are not used by the industry.	Develop framework for identifying 'high value' rail data sets. Further development of the T1184 framework to identify priority data sets for sharing. Ongoing development of business cases to enable increasing amounts of open or shareable data. Development of strategy and routemap towards achieving an 'open by default' data-sharing vision. Implementation of routemap to 'open by default' data-sharing.	Widespread ability to build cross-industry business cases for the sharing of data. Data is being shared at the right level of openness. High-value datasets are being made available.	
Tools and skills for better data exploitation	Advanced data capabilities are essential for the railway to drive and be competitive and integrated with other modes.	Rail expertise exists for traditional analytics. Cross-industry competence in new approaches to data is limited. Industry is not always an informed buyer and user of 'big data' and 'smart data' solutions.	Identify skill gaps within industry. Develop and implement (re)training, support and guidance. 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. Focus digital twins, AI and other data analysis developments that underpin the other four functional priorities.	Strategy for ensuring a digitally talented workforce has been implemented. Digital twin capability is strong. Advanced AI techniques are widely available and being used.	

Data driven
Progress against short-term vision

RTS Innovating across Britain's railway

GOALS	RECENT POSITION (2020)	RECENT PROGRESS AGAINST STEPPING STONES			VISION FOR 2025
Easy access and sharing of data, including real-time data	A limited range of data is available through industry platforms/APIs. Most data sets are not available or accessible. A range of assets and other sources generate data in real time, but this capability is not widely exploited.	**Create and facilitate data sharing mechanisms.** RDG Rail Data Marketplace (RDM) project is scheduled for delivery in November 2022. NRd development of Enhanced Network Rail Information Exchange (ENRICH) Programme.	**Agree levels of data-sharing and develop template data-sharing agreements.** RDG The RDM project will provide template contracts for different data-sharing agreements, through the Marketplace.	**Capability for multi-modal data-sharing** RDG RDM and DfT Ongoing coordination with DfT to enable compatibility of RDM with the 'Find Transport Data' DfT national access point facility.	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. Compatibility of rail data-sharing approaches enables multi-modal data exploitation.
		Establishment of GBR Digital Data Service. GBR Commitment 56 of the William-Shapps Plan for Rail tasks GBR Digital Data Service with removing barriers to data-sharing and setting performance targets for opening up data.	**Create and manage priority pipeline of data sets.** RDG The RDM project is creating a dataset pipeline, informed by User Research. RTS review of other priority themes, and other industry strategies, will inform the data pipeline.		
Robust industry-wide data governance	Several organisations are developing, or have developed, information management frameworks.	**Agree a cross-industry information management framework (IMF), including cyber-security issues.** DISIC The working group has produced agreed statement of IMF principles for rail, based on Gemini Principles.	**Cross-mapping of IMF principles to industry initiatives and activities.**	**Ensuring all IMF principles are sufficiently addressed within rail ecosystem.**	Cross-industry data standards being produced and adopted. Rail Information Management Framework principles being met on cross-industry basis.
		Develop cross-industry metadata to be used in data cataloguing. DISIC Initial metadata structure being used for RDM User Research.	**Determine strategy for data standards.** RSSB Establishment of a new Data, Systems & Telematics Standards Committee. GBR role in development of data-sharing standards and frameworks.	**Implementation of data standards routemap.**	
Clear business case for data sharing	There is limited research focusing on quantifying the benefits of opening up data sources. Traceability capabilities exist but are not used by the industry.	**Develop framework for identifying 'high value' rail data sets.** RSSB Research project T1184 (Framework for valuing GB rail data) comprises a six stage process and prototype framework. A trial of the prototype approach identified the requirement for further development.	**Further development of the T1184 framework to identify priority data sets for sharing.**	**Ongoing development of business cases to enable increasing amounts of open or shareable data.**	Widespread ability to build cross-industry business cases for the sharing of data. Data is being shared at the right level of openness. High-value datasets are being made available.
		Development of strategy and routemap towards achieving an 'open by default' data-sharing vision. GBR Commitment 56 of the Williams-Shapps Plan for Rail refers to the introduction of an 'open by default' approach, with common frameworks and standards across the sector created and led by a new Rail Data Service within GBR.	**Implementation of routemap to 'open by default' data-sharing.**		
Tools and skills for better data exploitation	Rail expertise exists for traditional analytics. Cross-industry competence in new approaches to data is limited. Industry is not always an informed buyer and user of 'big data' and 'smart data' solutions.	**Identify skill gaps within industry.** RSSB, NSAR and WISP NSAR has been commissioned, through the Whole Industry Strategic Plan (WISP), to review current workforce, assess future skills and identify gaps, which will include digital skills.	**Develop and implement (re)training, support and guidance.** NSAR		Strategy for ensuring a digitally talented workforce has been implemented. Digital twin capability is strong. Advanced AI techniques are widely available and being used.
		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. UKRRIN, NR, RSSB and suppliers. The University of Birmingham has developed a digital twin of the West Midlands network to analyse passenger traffic during the Commonwealth Games and beyond, and is also working with HS2 to model digital scenarios for networks that are currently under construction.	**Focus digital twins, AI and other data analysis developments that underpin the other four functional priorities.** The West Midlands digital twin supports the Easy to Use for All and Optimised Train Operations functional priorities.		

Suggested industry-level owners are underlined. NR – Network Rail RDC – Rail Data Council RDM – Rail Data Marketplace DISIC – Data & Information Systems System Interface Committee NSAR – National Skills Academy for Rail GBR – Great British Railways RDG - Rail Delivery Group
UKRRIN – UK Rail Research & Innovation Network WISP – Whole Industry Strategic Plan

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Rail Technical Strategy

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

BUSINESS DRIVEN INNOVATION

Collaborative research and innovation with a strong industry pull, drives and de-risks take-up. The journey from research to innovation leverages funding and expertise from the supply chain and the academic community.

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.

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.

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.

RAPID BENEFIT REALISATION

Streamlined, reliable and timely deployment of novel solutions is driven by proactive and creative route-to-market thinking. This needs to recognise the critical role that people buy-in plays for fast-paced and successful adoption of new solutions. The effective alignment with insertion points and the opportunity of working backwards from key insertion points have a key role to play in ensuring the benefits are maximised.

What is in place now

- 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

- 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

- 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

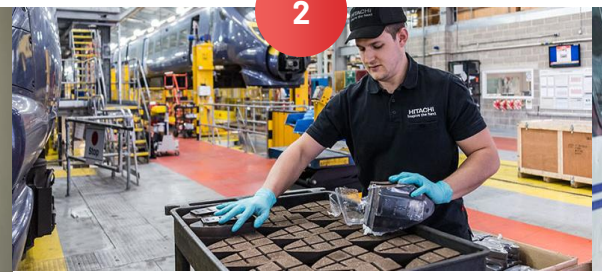
DESIRED **OUTCOMES**

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.

1

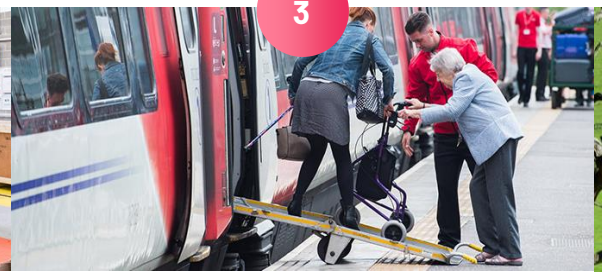
HAPPY CUSTOMERS
The mode of choice for passengers and freight

2



A VIBRANT SECTOR
A railway that attracts investment and talent

3



STRONGER SOCIETY AND ECONOMY
An accessible and affordable mode that supports the UK economy

4

BETTER ENVIRONMENT
Sustainable operations with a positive environmental impact

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.

DESIRED **OUTCOMES**

1

HAPPY CUSTOMERS

The mode of choice for passengers and freight

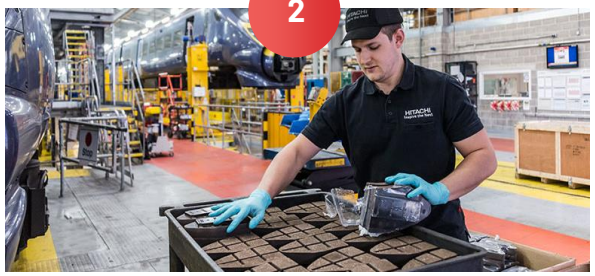
In a normal year, the railway moves close to 2 billion people and lifts over 17 billion net tonne-kilometres of freight which includes around 40% of domestic intermodal freight. Other surface transport modes are changing and evolving rapidly but cannot offer the level of capacity and safety that the railway provides.

But performance has been dropping in recent years, while frustrations over major project delivery and ever rising ticket prices are well known. There is much to be done.

During the Covid pandemic the railway has implemented extensive measures to keep passengers safe, but the situation continues to have significant impact on travelling needs and on passengers' confidence in using public transport. In the meantime, freight customers have experienced easier access the rail network allowing them to play a vital role in ensuring the continuation of supplies around the country in a green and efficient way.

Only technological advances designed and developed with the customer in mind will ensure that rail is the mode of choice for a wide passenger demographic and a broader swathe of the logistics sector.

2



A VIBRANT SECTOR

A railway that attracts investment and talent

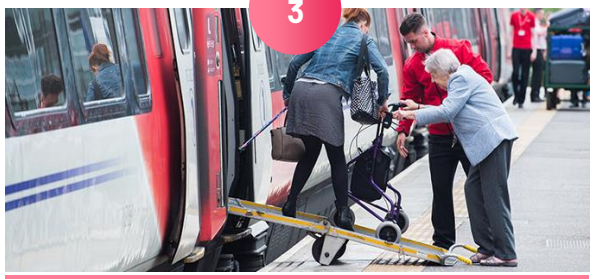
Creating an attractive sector to invest in and work for will ensure continued interest from both the talent and the capital that we need.

The future workforce needs to see rail as a desirable career path, with an exciting future underpinned by its rich history. Technology firms from start-ups to major international organisations should see rail as a primary target for which to develop new solutions and transfer existing solutions.

There is a strong framework on which to build and positive progress in many areas with over 4,000 suppliers delivering to Network Rail each year. Major infrastructure projects including HS2 open a multitude of new opportunities for innovative suppliers, whilst decarbonisation will bring significant opportunities in both infrastructure and rolling stock.

DESIRED **OUTCOMES**

3



STRONGER SOCIETY AND ECONOMY

An accessible and affordable mode that supports the UK economy

Transport provides opportunities to access employment and leisure, and to engage with families and friends. Rail can do this at scale and speed, enabling people to travel long distance in comfort and making it possible for large numbers to reach city centre jobs reliably.

By supporting the economies and communities it helps to connect, rail can be a fundamental component in helping the country build back better after the global pandemic and in levelling up regions with services shaped to fit local needs.

To do this rail needs to be accessible and inclusive – physically, financially and culturally. Maximising the proportion of the population who can easily and comfortably travel by train at affordable costs will unlock significant wider societal benefits across the country.

4

BETTER ENVIRONMENT

Sustainable operations with a positive environmental impact

The railway is already a low carbon mode, with over 70% of passenger km run by electric trains. But the sector still emits 3,500 ktonnes of CO_2 from traction alone and the freight side is overwhelmingly reliant on diesel. And while air emissions are similarly low, with rail responsible for just 2% of NOx and 1% of particulates, emissions can be significant at a local level and in some stations.

The industry is already making significant progress in reducing the impacts further, with cross sectoral consensus on carbon and air quality strategies, and plans to significantly extend electrification.

New technology will be critical to delivering – whether new traction options such as hydrogen and battery, improvements in electrification or retrofitting existing trains to be cleaner and more efficient.

In the new green economy rail will play a central role in delivering a resilient, integrated transport network.

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.

It is also key to recognise the exceptional times at which this strategy is published. Covid-19 has brought unprecedent and long-term changes in the way we live and travel. These require 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 evolves, 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

Rail Technical Strategy

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

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