Rail Technical Strategy

Innovating across Britain's railway

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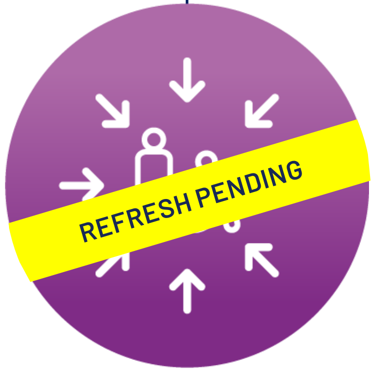
FUNCTIONAL PRIORITIES

The five functional priorities are industry agreed focus areas where rapid technical progress is critical. For each priority, a 'routemap' highlights the steps needed in the next few years to ensure that new technical solutions can underpin progress towards the key goals.

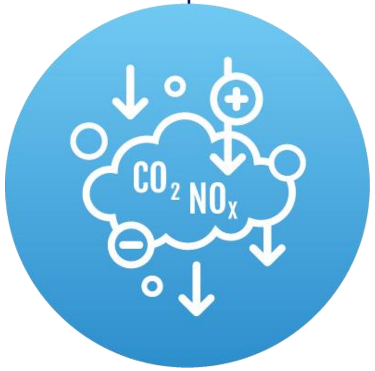


EASY TO USE FOR ALL

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

FREIGHT FRIENDLY

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



LOW EMISSIONS

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

OPTIMISED TRAIN OPERATIONS

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

EFFICIENT AND RELIABLE ASSETS

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

Easy to use for all

*REFRESH PENDING

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GOALS	WHY?	STATUS IN 2020	STEPPING STONES OVER THE NEXT 5 TO 8 YEARS	VISION FOR 2040
Accurate, accessible and understandable real-time information	Making it easier for passengers to plan and manage their journey reduces stress, exclusion and time lost, and increases confidence.	Real-time information is available but not always reliable and useful. Also staff on the ground often don't have the same information. New need for information relating to biosecurity in rail environments.	Improvements in the timeliness, reliability and accuracy of the information needed for door-to-door travelling, including information on layout and current status of facilities of stations and trains. Personalised information sent to customers based on their journey and travelling patterns. Development of biosafety indicators that support customers and industry decisions. The availability of data enables new services from the wider market that cover door-to-door needs. These include information interface for mobile devices, hearing aids and station navigation tools.	Timely, easy to use and reliable door-to-door information with rail at its heart.
Smart fare collection	For rail to be attractive it is key that passengers can easily buy rail as part of their travelling options and door-to-door journey.	Ticketing is complex and offers limited flexibility. Lack of clarity on best price available. Limited cross-modal payment options, mainly in urban areas and for train-bus combinations.	Rail pay as you go to cover frequent, shorter and cheaper journeys (including city, regional and intra-regional). 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.	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.	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.	
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.	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.

Freight friendly

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

Low emissions

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GOALS	WHY?	STATUS IN 2024	STEPPING STONES OVER THE NEXT 5 TO 8 YEARS	VISION FOR 2040

Stepping stones across several goals:

- Develop an updated and agreed plan of the end-state traction choices on different parts of the network. ↗1,2,3,4,5
- Learn lessons from battery and multi-mode trains operating on the GB network and internationally. ↗1,2,3,4,5
- Improve understanding of power regulation and max power draw requirements to make the most of existing electrification and reduce overall energy consumption. ↗1,2,3,4
- Develop and demonstrate options for smart management of power supply and demand during train planning and real-time operations with the aim to accommodate the maximum number of electrically powered journeys within the capability of the power supply. ↗1,2,3,4 ↗Optimised train operations

Efficient new electrification (1)

Why?

Combined with modal shift, further electrification of the rail network is a fundamental step towards achieving the UK's 2050 net-zero target.

Future electrification – whether full or partial - must be affordable, deliver operational resilience, and cater for smart interactions with trains.

Status in 2024

Full electrification is recognised as the optimum choice for high-speed, high-intensity routes. Partial electrification, combined with multi-mode trains, is a viable contender on other routes.

A range of solutions, including voltage control clearances, insulated pantograph horns, and increased span lengths, have started to address the cost and disruption challenge associated with new electrification.

Stepping stones

- Embed adoption of the cost-efficient electrification solutions in all new electrification projects to reduce the cost and embedded carbon content.
- Continue to develop cost-efficient electrification optimised to the GB railway gauge.
- Revisit lower sector gauge to be able to implement the Merseyrail type conductor rail shroud on Southern region in the longer term.
- Review electrification assurance and authorisation process to improve efficiency and efficacy.

Zero carbon self-powered vehicles (2)

Why?

Battery and multi-mode operations can deliver the requirements of passenger trains on lower-speed, lower intensity routes.

As batteries and the associated charging infrastructure continue to improve, there is an opportunity to make the most of these developments.

Status in 2024

Train manufactures have continued to improve the capabilities of battery and multi-mode vehicles. Initial deployments have happened in GB and several other countries.

The procurement of further multi-mode fleets for the GB network has commenced but uncertainties remain, such as around whole-life costs, battery longevity, and ability to charge off existing electrification.

Stepping stones

- Agree whole-life costing and carbon framework to support capital investment decisions on possible different mixes of track and train traction choices on branch lines. ↗1,2,3
- Document lessons learned from Scotland, Core Valley Lines, Midland Main Line and TransPennine electrification schemes.
- Develop and trial options for alternative power supply technologies / configurations on secondary lines (for example. Scott Transformers, Mini-SFCs). ↗1,2,3,4
- Develop technical standards and commercial guidance, informed by whole-system considerations, to support the procurement and introduction of self-powered and multi-mode vehicles, and supporting infrastructure.
- Agree technical and operational options for partial electrification to make best use of rolling stock and infrastructure capabilities, including charging opportunities for battery trains. ↗1,2,3,4
- Develop and agree operational control options to enable the reliable running and charging of battery trains. ↗2,3,4
- Investigate solutions to de-risk and speed up transitions between traction modes, including carrying out a review of bi-mode changeover process to avoid manual interventions and make automatic solutions quicker. ↗2,3

Vision for 2040 (goals 1 and 2)

Progress towards a net-zero railway by 2050 is well underway. ↗1,2,3,4,7

All high-speed, high-intensity lines are electrified with high capacity, energy efficient systems that represent value for money.

Battery and multi-mode trains, supported by partial electrification, operate successfully and efficiently on the network.

Low carbon freight and on-track machines (3)

Why?

There is currently no viable alternative to electrification or (bio)diesel to deliver the power necessary for the full range of freight journeys on the GB network. Electric traction offers capacity and operational benefits over diesel.

Without action, rail freight risks being less favoured than other modes as they continue to decarbonise. This could cause long-term congestion and economic disbenefit if a lower proportion of freight is moved by rail.

Status in 2024

Industry is currently introducing bi-/tri-mode locomotives which are envisaged to deliver significant last-mile benefits and operational flexibility.

But traction electricity charges and spikes in electricity prices can make it more cost-effective to haul using diesel.

Industry is looking into maximising the benefits of future electrification for freight, including freight infill.

Stepping stones

- Assess freight power options based on the capabilities of the electrified network, plans for future traction energy, and freight-specific technology developments.
- Evaluate options for self-powered wagons, including utilising regenerative braking technology, to improve acceleration capabilities that unlock new pathing options.
- Develop path modelling capabilities that consider whole-system impact and benefit to UK PLC, including economic and carbon impacts of rail freight.
- Improve traffic management utilising C-DAS to enable better on-the-day regulation decisions that are underpinned by improved freight pathing algorithms. ↗2,3,4
- Assess actual performance of novel low-carbon fuels, and the feasibility and costs of associated engine changes.
- Explore the feasibility of intelligent / dynamic freight consist arrangements to reduce aerodynamic drag.
- Explore optimised electrification designs and solutions for secondary freight-only routes.
- Explore options for integrated charging facilities for both road and rail at terminals.
- Assess low-cost electrification options at terminals.

Vision for 2040

There is a clear role and relevance for rail as part of an overall net-zero logistics chain.

Intelligent energy management (4)

Why?

Existing electrified lines face an increasing demand for power from electric and multi-mode services.

Better understanding of real-time power demand and capacity, coupled with a strategy for alleviating constraints and reducing energy losses, is crucial to a low-emission railway.

Status in 2024

Numerous areas have declared power supply constraints, and more are anticipated in the next Control Period.

The development of the whole-system thinking required to improve the management of power supply and demand has started but is still in its infancy.

Stepping stones

- Assess the technical and economic viability of using lineside energy banks to complement traction power supply.
- Further assess and pilot the technical and economic viability of using lineside renewables to complement traction power supply.
- Develop a range of options to remove / alleviate existing energy supply constraints on main lines. ↗1,3,4
- Improve measurement of energy consumption of trains, including energy quality experienced by trains running under the wires.
- Develop mechanisms to bring together consumption data to have a better whole-system view.
- Explore costed options to reduce losses on the DC network.

Vision for 2040

Network traction power constraints are actively managed, with plans in place to remediate.

Traction energy consumption is minimised. Demand for electrical power is managed dynamically to make the most of available capacity.

Cleaner air (5)

Why?

Air quality is the most pressing environmental health risk in the UK, generating the urgent need to mitigate harmful pollutants from rail.

Status in 2024

The understanding of the scale and location of air pollution on the network has increased, with some mitigations being trialled.

Stepping stones

- Establish the air-quality benefits of hydrotreated vegetable oil and synthetic fuels.
- Improve understanding of the impact of station ventilation solutions
- Consider vulnerabilities and potential improvements of HVAC systems on trains.
- Review technologies to support train idling reduction initiatives.
- Develop options and business case for retrofittable air quality mitigations, such as exhaust treatments.

Quieter railway (6)

Why?

The growth of housing in rail proximity, and demand for services to run for longer hours, make the noise pollution generated by rail increasingly unacceptable.

Status in 2024

The underlying causes of noise relating to wheel squeal and engines are poorly understood, making prevention and mitigation challenging.

Stepping stones

- Test and deploy affordable solutions to gain proactive awareness of noise hotspots and their evolution over time.
- Develop and trial solutions that alert level crossing users at the crossing itself.
- Improve understanding of noise generated by engines and explore auxiliary power solutions to minimise it.
- Bring together noise and vehicle dynamics experts to understand and mitigate the causes of wheel-rail noise.

Vision for 2040 (goals 5 and 6)

Air pollutants and noise from rail operations are minimised to protect the health and wellbeing of the workforce, customers, and local communities.

Lowering embodied carbon of key material (7)

Why?

Key materials, such as steel and concrete, which make up the fabric of the railway, have high levels of embodied carbon.

As a significant purchaser, rail has a role to play in driving the reduction of embodied carbon.

Status in 2024

Initiatives across the industry have started to look at the role rail can play as a significant buyer of concrete and steel.

Alterative carbon-friendlier materials are being trialled for rail applications, but there is limited clarity on the required performance level.

Stepping stones

- Identify best practice from other sectors on recycling and circular economies, including incentive mechanisms.
- Investigate life-cycle of traction batteries, including possible second use in rail, to minimise environmental impact and maximise whole-life value. ↗2,3,7
- Steel, concrete, quarry economy - improve carbon quantification for the whole lifecycle of these materials including definition of the most appropriate boundaries from different questions and analysis.
- Develop emission benchmarks for specific assets to inform design targets.
- Test low-carbon concrete alternatives against performance specifications.
- Improve steel scrap cycle to enable and monitor an integrated scrap route that keeps good quality rail scraps in GB.
- Learn lessons from the early deployment of existing composite solutions to inform further use and research needs.

Vision for 2040

The embodied carbon of rail assets is well understood and continues to be driven down.

Optimised train operations

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GOALS	WHY?	STATUS IN 2024	VISION FOR 2040
Infrastructure and train capabilities to overcome capacity constraints 1	There is the need to cater for reliable high-frequency services on parts of the network where capacity is constrained either because of headway lengths or bottlenecks at nodes. In progressing the roll-out of digital signalling, there is an opportunity to extract early value from this investment.	ETCS is being implemented on the southern section of the East Coast Main Line and on the Transpennine Route Upgrade, with planned further expansion on the West Coast, Midlands, and Brighton Mainlines. New rolling stock is increasingly equipped to support in-cab signalling, and CP7 will see ETCS fitment across fleets ramping up. Nationwide deployment of the infrastructure supporting these advanced systems remains a long-term plan, therefore in many locations train capabilities won't be fully exploited for some time.	Capacity constraints have been overcome in effective and efficient ways.
Simpler and safer real-time operations and decisions 2	A simpler-to-operate railway enables better and safer service delivery at lower cost. Short-term solutions to improve and support operational tasks and decisions exist. The migration to new solutions, including digital signalling, must not add complexity and risks, and must strive to deliver early benefits.	Traffic Management has been deployed on the Western Route to minimise service disruption, provide accurate passenger information, and enhance operational performance. The deployment of C-DAS has seen limited progress due to challenges around the complexity of integrating the various systems required for its operation. Technical solutions to enable more informed and / or automatic interventions have started to be explored; for example, in the space of speed control and AI - powered review of safety-critical communications.	Operational tasks and decisions are optimised and automated through technology that makes the rail system easier to operate with customers at its core.
Improved recovery from incidents and disruptions 3	The ability of staff in Control and on the ground to safely, effectively and quickly manage and recover from incidents and disruptive events is critical to limiting disruption to customers. This requires a combination of new technologies and changes in current processes.	Recovery from incidents and disruptions remains a challenge across the network. High-profile incidents have raised questions about how to improve operational decision making in these challenging circumstances. The Industry Train Service Recovery (ITSR) framework has been rolled out across control centres and provides a common approach to incident recovery within Control. Setting up degraded working procedures continues to take time and, once in place, these significantly reduce the throughput of trains.	Rapid recovery from disruptions that minimise the adverse effects on railway customers is routinely achieved.
Reliable and flexible train planning 4	Timetabling plays an essential role in making the most of existing network capabilities and delivering a reliable railway. Having easier, agile and robust ways to change and add train paths allows greater responsiveness to changes in network availability, and in passenger and freight demand.	The timetable remains based on train planning rules (TPR) and contingency within them to deliver timetable resilience limits capacity, particularly at nodes. Demonstrators to make 'very short-term planning' processes less manual and more robust using a 'track section occupancy' approach have been developed. These techniques could also be used to achieve seamlessness between 'very short-term planning' and 'short-term planning', and be applied earlier in the planning cycle.	Underpinned by greater automation and use of data, timetabling and train planning optimise the use of the network in a flexible and reliable way.
More affordable solutions for lower-use lines 5	The long-term viability of lines with low traffic is at risk. Their future economic sustainability requires reducing capital and operational costs, while offering safe, reliable services.	Radio Electronic Token Block (RETB) has been enhanced on the Far North line to enhance asset reliability and functionality. New low-cost systems are being developed for light rail and lower-use lines.	Lower-use lines are affordable to serve their societal and feeder function to the main rail network.

STEPPING STONES OVER THE NEXT 5 TO 8 YEARS

Cross-cutting stepping stones

- Plan the migration to Automatic Train Operation (Grade Of Automation 2) including accelerating the introduction of targeted aspects of automation in train operations to improve system reliability and capacity (for example by implementing ABDO, CSDE and C-DAS).
- Define a range of strategic operational requirements for different parts of the network to optimise and test changes against quantifiable targets and control changes. ↗1,2,3,4,5
- Define information on network capabilities and constraints (e.g. level crossings, platform length, traction power characteristics) to improve and unlock capacity at different stages of investment and timetable planning. Make this information digitally available to avoid duplication of effort and encourage novel solutions. ↗1,2,3,4,5
- Define and use standardised data interfaces to make it easier and quicker to scale and federate simulation and modelling tools that can inform long-term planning and validate operational concepts and choices. ↗1,2,3,4,5
- Agree a plan to roll out a system-wide compatible Traffic Management with standardised data formats and sharing arrangements, on which functionalities such as C-DAS, stock and crew management, and efficient energy management could be added incrementally. ↗1,2,3,4
- Develop and implement an Operational Voice Comms Strategy for both primary and secondary communication to remove outdated technologies and be ready to adopt FRMCS. ↗1,2,3,5
- Develop options for the migration to FRMCS in different parts of the network. ↗1,2,5

Goal 1 – Infrastructure and train capabilities to overcome capacity constraints

- Keep a watching brief on the development in Europe's Rail toward Automatic Train Operation (Grade Of Automation 4).
- Adopt improved methodology for train planning rules to exploit ETCS. ↗1,4
- Remain involved in the System Pillar of the Europe's Rail Joint Undertaking (EU-Rail) which is set to deliver a unified operational concept and a functional, safe and secure CCS system architecture. ↗1,2
- Update the long-term deployment plan for ETCS.
- Undertake analysis at key bottlenecks to prioritise specific, targeted improvements to existing signalling designs to enable capacity enhancements.

Goal 2 – Simpler and safer real-time operations and decisions

- Agree Train Protection Strategy (including speed management) to improve safety and accelerate availability of operational solutions traditionally associated with digital signalling, such the ability for more granular speed restrictions. ↗1,2
- Develop a network model and a speed restriction management system to feed into digital and conventional signalling, therefore enabling cab-fitted speed management for class b trains, and into train planning systems. ↗1,2,4
- Pursue proof of concept(s) of economically viable solutions that mitigate transition risk between ETCS-fitted areas and exploit ETCS-fitted rolling stock.
- Develop an implementation plan for enhanced train protection in light of the ETCS long-term deployment plan and outcomes of proof of concept(s).
- Establish clear adhesion braking targets and testing criteria for representative conditions. Develop a framework to inform the mix of existing adhesion mitigations to deliver against the targets, and determine whether and what new mitigations are needed. ↗1,2,4
- Develop and deploy solutions to make full use of operational data to generate and share insights, feedback and learning opportunities for front-line staff (for example automated indicators for driver performance, automated review of safety critical communication). ↗2,3
- Adopt standardised design and operational interfaces for signalling solutions (and transitions between signalling systems) to reduce complexity and the need for specialist / ad hoc training.

Goal 3 – Improved recovery from incidents and disruptions

- Develop, test and introduce alternatives to the traditional approach to pilot working in degraded conditions so that this can be deployed faster and more effectively following an incident.
- Improve data and insights available to staff in Control rooms to better understand issues (such as loading data, or front-facing CCTV).
- Improve and make greater use of decision-support tools and dynamic risk assessments to enable continuation of train movements and minimisation of service stoppages or restrictions.
- Develop and assess solutions to augment staff competency during, and in preparation for disruptions.
- Fully deploy and continue to improve data-driven, risk-based approaches to the introduction and removal of speed restrictions to minimise performance impact without compromising safety. ↗2,3
- Improve capability to rapidly and effectively introduce and step out of contingency plans to improve response to disruptive events. ↗2,3
- Develop predictive modelling capabilities powered / strengthened by AI to inform near real-time service recovery interventions by Control.

Goal 4 – Reliable and flexible train planning

- Establish clear and formal links between long and short-term asset planning (infrastructure and rolling stock) and timetabling to ensure the capacity needed is built and existing capacity is exploited. ↗1,4
- Develop and demonstrate options for smart management of power supply and demand during train planning and real-time operations with the aim to accommodate the maximum number of electrically powered journeys within the capability of the power supply. ↗1,2,3,4 ↗Low emissions
- Strengthen links between train planning and traffic management systems to move towards seamless integration that reduces task duplication and shortens communication chains. ↗2,3,4
- Progress toward the adoption of the demonstrators created to deliver greater automation and shorten the timescales when adding / changing train paths at 'short' and 'very short' notice. ↗1,4
- Establish common reference data for train crew availability, to underpin increased integration between traffic management and stock and crew. ↗2,3,4
- Improve insights on actual usage of allocated train paths and their associated value.
- Improve insights on actual usage of possessions.
- Review the need and rationale for the boundaries between 'short-term planning' and 'very short-term planning'.

Goal 5 – More affordable solutions for lower-use lines

- Explore new solutions to extend the life of conventional signalling on branch lines.
- Assess enhancements made to RETB in Scotland to understand the case for similar solutions on low-volume traffic routes, enabling the removal of conventional signalling.
- Establish sets of requirements for signalling solutions on lower-use lines which can drive down costs and deployment time.
- Explore solutions for co-existence of different types of rail vehicles and operations.
- Keep a watching brief on the regional railway system demonstrator (Europe's rail FA6) to consider the insights generated in a timely fashion.

Efficient and reliable assets

RTS Innovating across Britain's railway

GOALS	WHY?	STATUS IN 2024	VISION FOR 2040
"Right-time" actionable insights 1	The timely availability of actionable insights on asset condition is key to service reliability and efficient maintenance interventions. Solutions to monitor assets continue to grow and improve. These offer great potential if full value can be extracted from affordable deployments.	Rolling stock data availability greatly varies by age of fleet. Increased insight is available for fixed linear assets, particularly thanks to in-service train-borne monitoring solutions. These are opening new opportunities for the future mix of monitoring solutions. Network Rail's Intelligent Infrastructure programme has provided a framework for greater data integration. The challenges of extracting actionable insights from these developments and using them to change established ways of working remain.	The wealth of asset data captured, particularly from in-service trains, is easily accessible and used to generate valuable and actionable insights. This allows operational decisions and asset interventions that deliver a highly reliable and efficient railway.
Efficient, effective and safe maintenance, including renewals and overhauls 2	Only by pursuing the best mix of short, medium and long-term interventions, can maintenance be truly efficient and effective. Increased automation could improve the safety and health of the workforce and, at the same time, increase the quality and consistency of the results.	Numerous initiatives to make maintenance safer and more efficient have been undertaken. Promising research on automated solutions, for example to repair linear assets, are navigating the challenges related to business case and cultural acceptability.	Rail maintenance has been revolutionised through the integration of cutting-edge technology, data-driven decision-making, and a culture of continuous improvement. This ensure high levels of safety, efficiency, and effectiveness for maintenance interventions.
Improved resilience to climate change and extreme weather events 3	Extreme weather events have a significant negative impact on both the safety and reliability of the network. With climate change increasing the frequency of extreme events, there is a need to identify, prioritise, and deploy cost-effective responses and mitigations to increase the resilience of the network and its operations.	Extreme weather events, such as the 2022 heatwave and the prolonged rainfall in 2023, had significant safety and performance consequences. As a result, rail is in the process of improving forecasting capability and operational response to extreme rainfall. For extreme heat, engineering standards for track have been updated and new inspection capabilities developed. There are still significant knowledge and capability gaps to move from reactive to proactive interventions.	Rail assets and operations have improved their resilience to extreme weather events and continue to adapt to climate change in a targeted and risk-driven way.
Speed up and de-risk introduction of assets 4	Reducing the time and resources needed for the safe introduction of new assets could deliver important benefits. With the pace of improvement of digital environments, testing and validation can evolve to cut cost and time while also derisking the introduction of innovative solutions.	There is consensus from industry and supply chain that testing and validation requirements for new assets are not always clear and proportionate. The ability to gather data from full-scale accelerated trials remains limited, leading to long timescales for the testing, validation, and acceptance of novel products such as composite sleepers. Digital testing solutions are rapidly evolving and improving but there are no agreed criteria on how to assess their quality.	New assets and novel solutions are introduced easily, in a timely way, and robustly thanks to widespread use of digital environments and value-adding full scale physical testing.
Proactive management of asset obsolescence for safe & efficient operations 5	In the context of increased use of digital technology and financial constraints on renewals, the challenges of obsolescence management have changed and increased, requiring a more robust and informed approach.	The industry is still experiencing a tactical response to product obsolescence which is not well co-ordinated across organisations facing similar challenges. Pressures on renewal investments increase the need to keep assets in operation for longer.	Systems successfully cater for components with varied lifespans to exploit rapidly changing digital capabilities and the economic and environmental benefits of longer-lifespan assets.

STEPPING STONES OVER THE NEXT 5 TO 8 YEARS

1 – "Right-time" actionable insights

- Review, prioritise and share with supply chain the current asset monitoring challenges.
- Introduce technology to accurately and repeatably capture the location of new and existing assets, mapping this information to an updated single version of the truth network model for fixed infrastructure.
- Establish efficient and effective frameworks for multi-party data capture, data storage, data sharing and integration, and post-processing insights. These need to cover data ownership, costs, and liabilities.
- Develop a cross-industry strategy for future investment and adoption of RCM solutions to inform Network Rail infrastructure monitoring fleet upgrade, make the most of in-service monitoring, and rationalise current and future solutions.
- For a wider range of assets, demonstrate the data quality that can be achieved from measurements taken from in-service trains when compared to calibrated sensors on the Network Rail infrastructure monitoring fleet. This needs to include consideration of level of fitment needed on in-service trains and the data requirements of end users managing asset condition and operational risks.
- Develop the strategy and specification for in-service monitoring and diagnostic of ETCS systems.
- Integrate right-time asset insights into maintenance cycles, continuing to move away from routine inspection and maintenance of both rolling stock and fixed assets. ↗1,2
- Explore introduction of edge computing on-board asset monitoring systems for real-time data processing and analysis. ↗1,2

2 – Efficient, effective and safe maintenance, including renewals and overhauls

- Continue the technical development and operationalisation of specific solutions such as Discrete Defect Repair, Panoptic Bridge Inspection, Tenanted Arch Inspection and Automated Tunnel Examination to inform the roadmap to wider adoption of autonomous maintenance technology.
- Ensure updates to the Rulebook support the adoption of autonomous inspection and maintenance solutions to come such as the Network Rail Robotic Inspection & Maintenance Vehicle demonstrator.
- Develop standards on the communication, navigation and data transfer required to enable safe, reliable autonomous plant operation.
- Where lineside site working is still unavoidable, pilot and roll out a range of solutions to improve workforce safety and reduce exposure to occupational health hazards such as manual handling, slips trips and falls and exposure to noise, fumes, and dust.
- Develop a dedicated 'boots off ballast' strategy for fixed infrastructure inspection, maintenance and renewal.
- Improve KPIs for depots to inform investment decisions.
- Encourage use of tech to monitor health, fatigue and well-being of maintenance workers. This includes roll out of existing tech, and monitoring of emerging solutions.

3 – Improved resilience to climate change and extreme weather events

- Develop robust cost frameworks for key asset types that enable comparison of the whole-life cost of different capital investment options as well as different maintenance and renewal options, including the cost of sustaining obsolete design vs pursuing upgrades. ↗2,3,5
- Improve algorithms to turn 'weather forecasts' (temperature, rainfall and wind) into 'rail forecasts'. These improved forecasts will allow for better 'early warnings' based on safety and reliability risk.
- Develop and improve tools to ensure that the operational response for extreme weather events is informed by right time asset conditions and robust 'rail forecasts'. ↗Optimised Train Operations: 2,3
- Review operational rules relating to extreme weather.
- Include in the review of assets monitoring challenges, new and different needs driven by extreme weather events (e.g. rail thermal stress; drainage systems; ground saturation; air con system). This needs to consider how extreme weather would influence frequency and granularity of the data required. ↗1,3
- Improve consistent recording and mapping of the impacts of extreme weather events on rail assets and operations.
- Develop a system view of priority interventions from regions, routes and operators, and a cost-benefit analysis framework to inform the selection of weather and climate resilience investment decisions. This should also consider other transport modes to deliver best 'value' for national and regional connectivity.
- Analyse and re-define asset engineering standards for mitigating extreme weather events and improving climate change resilience, considering both technical and economic considerations.

4 – Speed up and de-risk introduction of assets

- Enhance guidance and support on efficient and effective pathways to testing, validation and approval.
- Review challenges and opportunities with testing, validation and acceptance of specific asset groups, leading to the production of helpful guidance.
- Improve availability of asset data that is representative of different parts of the GB rail network to feed into digital testing tools.
- Improve validation and assurance processes for digital testing tools (and associated synthetic environments) to enable greater and more informed use of these and more focussed and value-adding physical testing.
- Ensure operational scenarios, use cases, and testing parameters are clearly defined from the outset and drive validation and assurance.
- Explore commercial models and technical enablers for testing data to be made more widely available.
- Develop Minimum Viable Product of a synthetic environment to accelerate design, testing and validation of ETCS renewals and support their transition into BAU (part of Network Rail T190). Use lessons from this to inform the development of synthetic environments to accelerate design, testing and validation of other asset types.
- Develop skills in parallel with new solutions and ensure competency management caters for legacy assets. ↗4,5

5 – Proactive management of asset obsolescence for safe & efficient operations

- Achieve increased modularity in components for faster and easier maintainability and replacement, for example for capacitors and semiconductors.
- Investigate commercial approaches to enable a viable and affordable supply chain for legacy components and systems.
- Improve information sharing to enhance prevention and dynamically respond to cyber security threats.
- Repair and maintain Solid State Interlocking components to extend asset life, including the creation of a database of units to understand availability.
- Develop set of requirements to easily address compatibility, upgrading, and replacement issues of digital components (hardware and software) in all new assets.

Across goals

- Develop validation and assurance principles for AI-powered solutions designed to generate insights and support asset driven decisions. ↗1,2,3
- Agree a common asset and data ontology to enable data captured from different sources to be easily federated, including rules for capturing asset location at different levels of accuracy. This links to the need to define and gather information on network capabilities and constraints identified in the 'optimised train operations' priority. ↗1,2,3,4,5

Engage with the **RTS**

Explore the full strategy including the live components at:

www.**RailTechnicalStrategy**.co.uk

Share the technical solutions you are developing and deploying

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

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

Your feedback is welcome

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

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

Get in touch at:

rts@rssb.co.uk

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October 2024
Version 6.02