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Foreword

The railway needs to exploit Research, Development and Technology (R,D&T) to make train travel more comfortable, more accessible, more reliable and more affordable. Back in 2012 the first industry-led Rail Technical Strategy (RTS) was published. It described how R,D&T could enable the railway of the future, enabling unit costs to be halved, capacity to be doubled, carbon to be halved and the experience of customers to be transformed.

At the time, the level of investment in R,D&T was low so the first step was to ramp up the amount of R,D&T activity. Four years on and the industry has collaborated to establish a substantial pipeline of over 200 R,D&T projects and programmes. A major achievement. But, particularly in such a complex industry, how can we be sure we’re doing the right things, doing them once and giving them the right priority?

Having got more R,D&T underway, it is vital that we turn our attention to uniting the industry behind one programme - a single plan. A plan that focusses our efforts, expertise and investment so that we are indeed doing the right things, once, in priority order. A plan that ensures the ambition for new products, systems and equipment is matched by the facilities to support research, development, simulation, testing and validation. The RTS Capability Delivery Plan.

This single plan provides a baseline - or blueprint - against which the urgency and value of any R,D&T activity across the industry can be understood. Providing a link between R,D&T projects and capabilities built around clear advances in the way the railway could function in the future. It is being led by a new Technical Leadership Group that represents the Rail Delivery Group and the Rail Supply Group together with government.

Ultimately the railway exists to drive our economic prosperity. This single plan sets out capabilities that will enable the railway to offer better transport opportunities for passengers and freight. And it offers opportunities for industrial growth by expanding the range, and accelerating the readiness, of technologies to be taken up to make the future railway a reality.

Graham Hopkins
Chair of the Technical Leadership Group and Network Rail’s Group Director, Safety, Technical & Engineering
The Rail Technical Strategy Capability Delivery Plan (CDP) builds on the Industry’s Rail Technical Strategy, published in 2012. The CDP has been developed through consultation with experts from across the rail industry and the supply chain.

This CDP document, and the supporting online resource, identifies twelve whole system ‘Key Capabilities’ that the railway needs to develop in order to meet the industry’s objectives of increasing capacity and improving customer service in a sustainable and affordable manner.

The CDP includes milestones that build towards the delivery of the Key Capabilities and a programme structure that identifies the priority areas for technology development and deployment. Delivering against these priorities will provide quick win improvements to strengthen the case for funding. The CDP approach has been endorsed by the Rail Supply Group and the Rail Delivery Group. The industry’s Technical Leadership Group has taken ownership of the CDP and will be accountable for its delivery.

The twelve key capabilities are:

1. Running trains closer together
2. Minimal disruption to train services
3. Efficient passenger flows through stations and trains
4. More value from data
5. Optimum energy use
6. More space on trains
7. Services timed to the second
8. Intelligent trains
9. Personalised customer experience
10. Flexible freight
11. Low-cost railway solutions
12. Accelerated research, development and technology deployment

To deliver the CDP the rail industry and the supply chain will need to collaborate and new mechanisms for funding the development and deployment of technology into the railway system will need to be established. The outputs from existing investments into technologies, which support the delivery of the CDP, will need to be taken forward to market so that the industry can reap the benefits from the renaissance in UK led rail technologies.
Introduction

The GB railway and UK rail industry transports 1.65 billion passengers and 503.2 million tonnes of freight each year. Since 1997/98 the number of trains has doubled and the demand for rail transport is expected to continue growing. Rapid growth and changing customer expectations presents a challenge to the industry as current and conventional engineering and operational solutions struggle to meet demand. A long-term vision and action plan for integrating new technologies into the railway has the potential to address these challenges and open new markets to the railway to create a sustainable rail industry that offers better services, better journeys and better value, as a core part of the GB transport mix for future generations.

The Rail Technical Strategies (RTS), published in 2007 and 2012, set out a vision for a technologically-enabled railway that delivers efficient, affordable, flexible, and attractive transportation over the next 30 years. Passengers have more choice, more services, easier access, and greater comfort and connectivity, enabled through the development and deployment of technology. With rail’s, already impressive, safety and environmental credentials, this is a compelling vision.

There are twelve key industry capabilities in this plan that are intrinsic to realising the RTS vision. Delivery of these capabilities requires strong leadership, coordination, and collaboration from all parts of the industry. A united effort can ensure that the plan’s milestones are included in industry planning, and that funding is coordinated, targeted, and secured.

Rail is running the risk of being left behind other transport sectors, especially automotive, where technology development and deployment is enabling new business models and mobility solutions to prosper. Eleven of the twelve capabilities need technologies to be developed (or transferred), integrated and deployed.

Our twelfth capability, ‘Accelerated Research, Development and Technology Deployment’, aims to inspire greater confidence to the rail supply chain and private funders by increasing the pace of development and delivery.

In developing the Capability Delivery Plan an online suite of supporting resources and tools have been established. These will be of use to anyone wanting to engage with the RTS and the development and delivery of technology to the railway. These can be found on the RTS website at: www.rssb.co.uk/rail-technical-strategy
Overview

This Capability Delivery Plan builds on the RTS and the Network Rail Technical Strategy (NRTS) 2013. It also complements the Rail Supply Group Sector Strategy for productivity and growth in the UK rail supply chain – ‘Fast Track for Growth’. The plan is the culmination of a significant body of work developed by the rail industry since the publication of RTS, this includes:

- investments in research, development and technology demonstration that are maturing in to tangible solutions to railway challenges; and
- the definition of over 320 programmes of work - inspired by the RTS vision and aligned to the chapters within the RTS document.

The Capability Delivery Plan brings together these existing investments and the forward programme of work. It prioritises and aligns them in the context of delivering industry-wide, whole system, key capabilities that have the potential to deliver significant benefits to the railway and its customers.

The Capability Delivery Plan has been structured around a hierarchy that connects the portfolio of defined industry programmes through to the future technical vision and strategic goals for the railway.

This hierarchy, shown in Figure 1, eschews conventional rail industry silos and structures such as rolling stock and infrastructure in favour of looking at the railway as a whole system that is delivering services to a range of different markets all driven by the changing needs of the railway’s customers – both passengers and freight.

Structuring the Capability Delivery Plan around this hierarchy has enabled an assessment of which programmes are critical to the development of key capabilities that have the potential to enhance and ultimately transform the service proposition to customers.

This has enabled the portfolio of technology programmes assembled by industry experts to be prioritised.

Figure 1: Capability Delivery Plan Hierarchy

KEY:

Outcomes:
- Customer – Improve Customer Experience
- Capacity – Double Capacity
- Cost – Halve Cost
- Carbon – Halve Carbon

Programmes:
- Control, Command and Communication
- Energy
- Infrastructure
- Rolling Stock Energy
- Information
- Customer Experience
The RTS vision and strategic goals

A short video was created as a companion to the RTS which brought the various parts of the strategy together to show how these could combine to deliver a radically different railway service using existing track infrastructure. The video shows a railway where comfortable, energy efficient, rolling stock makes best use of the track infrastructure by allowing vehicles to slot in and out of available ‘gaps’ in the network, whilst passengers are kept up to date on their journey in real time via their mobile devices. Stations allow for passengers to move seamlessly from station to train without the need for paper tickets.

The technical vision for the railway needs to be responsive to changes in expectations from customers and these will change as attitudes to transport and mobility change. Significant trends that could have an impact on the vision include the widespread uptake of mobile connected devices and their use as part of journey exploration, planning and ticket purchasing. Significant global trends like increasing urbanisation and changing attitudes towards car ownership and work also have the potential to impact the types of service the railway needs to offer its customers in the future.

A range of future scenarios are possible and adapting RTS related programmes and activities to fit will be an ongoing and organic process. The Market Segment layer, within the hierarchy, provides the means to adapt the plan to different future scenarios by adjusting the proportions of the market segments. This in turn will influence the relative importance of the contributing key capabilities and programmes.

Irrespective of the future all the key capabilities within this plan have a role to play in delivering the future railway for GB and support the UK supply chain in developing new products and services with domestic and export potential.

Underpinning the vision are the four strategic goals for the railway – typically referred to as the 4Cs. The reduction of Costs by 50% or more, doubling of Capacity, halving Carbon emissions and improving Customer experience. In addition to these four goals a constraint can be added in that all of this is to be achieved whilst, as a minimum, safeguarding the safe operation of the railway.

Market segments

The GB railway services a wide variety of user needs and geographies. In order to express this diverse range of markets and potential new markets for the railway, six market segments have been defined in consultation with leading industry experts. Table 1 shows a list of the market segments and provides a brief description for each.

The market segments have been defined to be idealised national markets. Therefore, it is highly likely that any given route on the existing rail network will be a mixture of these. To aid understanding example routes on the existing network have been selected that illustrate each market.

The market segments provide a means of making sense of the key capabilities in terms of the relative merit of each capability to the idealised markets. For example the ‘running trains closer together’ key capability will deliver little benefit to the light demand railway where service frequency is constrained, not on technical grounds, but on economic grounds by the number of paying customers. Conversely the same capability has significant relevance to the high capacity commuter market as the increase in capacity and connectivity that this capability could deliver will have significant benefits.

Furthermore looking at the key capabilities through the ‘lens’ of the six markets helps to generate a clear ‘line of sight’ between the capabilities and how these translate through to achieving the industry goals. This in turn helps to identify the route to market for technology developments in a more regionally focused railway industry.
Key capabilities

The railway is a tightly coupled ‘system of systems’ where changes to any one part can have significant implications for other parts of the system. This interdependency between track infrastructure, rolling stock and command control and communications together with the structure of the UK rail industry creates a highly complex system with myriad interdependencies and misaligned incentives.

To manage the changes effectively and meet these challenges, the capability delivery plan introduces two concepts:

1. A set of twelve key capabilities which align the development, deployment, and delivery of technologies with the RTS vision.

2. For each key capability, a series of phased milestones that provide a framework for prioritising investments in the development and deployment of technology.

The key capabilities have been developed in accordance with the RTS, in consultation with industry experts, and are endorsed by the industry’s Technical Leadership Group (TLG).

Each of the key capabilities is elaborated on in the subsequent sections of the plan. Each section provides:

- a rich picture which sets out the ultimate vision for the capability;
- a description of the key capability and an example of an existing programme that is contributing to its delivery;
- the high-level industry milestones for the key capability; and
- an assessment of the annual economic benefits the key capability can deliver, in terms of the 4Cs, once the key capability is fully developed and deployed within relevant market segments.

### Table 1: Market segments

<table>
<thead>
<tr>
<th>Market segments</th>
<th>Description</th>
</tr>
</thead>
</table>
| Mixed Traffic            | All traffic types operating on the same railway. Decision to avoid prioritising particular markets.  
  Example: Great Western Main Line |
| High Capacity, Commuter  | Intensive use of rolling stock, track, and station capacity; yet resilient to perturbation. Flexible and optimised operation with other transport modes.  
  Example: Wessex Route: Woking to Waterloo |
| Dedicated (large and heavy freight) | Passenger services isolated from freight by time or by track.  
  Example: Sutton Park Line: Walsall to Castle Bromwich |
| City to City             | High-speed, high-capacity service between major transport hubs.  
  Example: East Coast Mainline: London to York |
| New Markets              | Identifying and exploiting unserved needs for freight and passengers, employing unutilised capacity in new ways.  
  Example: Borders Railway |
| Light Demand             | Rail for areas of the network where demand for rail travel is low - typically rural routes  
  Example: Heart of Wales Line |
### Twelve key capabilities

<table>
<thead>
<tr>
<th>No.</th>
<th>Capability</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Running trains closer together</td>
<td>£242 Million</td>
</tr>
<tr>
<td>02</td>
<td>Minimal disruption to train services</td>
<td>£658 Million</td>
</tr>
<tr>
<td>03</td>
<td>Efficient passenger flow through stations and trains</td>
<td>£258 Million</td>
</tr>
<tr>
<td>04</td>
<td>More value from data</td>
<td>£725 Million</td>
</tr>
<tr>
<td>05</td>
<td>Optimum energy use</td>
<td>£228 Million</td>
</tr>
<tr>
<td>06</td>
<td>More space on trains</td>
<td>£282 Million</td>
</tr>
<tr>
<td>07</td>
<td>Services timed to the second</td>
<td>£194 Million</td>
</tr>
<tr>
<td>08</td>
<td>Intelligent trains</td>
<td>£342 Million</td>
</tr>
<tr>
<td>09</td>
<td>Personalised customer experience</td>
<td>£40 Million</td>
</tr>
<tr>
<td>10</td>
<td>Flexible freight</td>
<td>£264 Million</td>
</tr>
<tr>
<td>11</td>
<td>Low-cost railway solutions</td>
<td>£157 Million</td>
</tr>
<tr>
<td>12</td>
<td>Accelerated research, development and technology deployment</td>
<td>£210 Million</td>
</tr>
</tbody>
</table>

**£725 Million**

**£458 Million**

**£282 Million**

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*Annul benefits assuming full implementation of the capability in appropriate market segments*
Services timed to the second
01 Running trains closer together

- Automatic/Autonomous Train Operation
- Predictable Braking
- Vehicle to Vehicle Comms
- Fast reliable fail-safe switching
- Accurate train positioning
- No line-side signals
- Whole system requirements definition
- Train vehicles from 1+ units
- Vehicles split and join on the move
Running trains closer together

The existing and future railway needs to accommodate higher passenger numbers and increasing customer mobility demands. For this, more paths and the capability to run trains closer together are required to expand the overall capacity and connectivity of the system. Ultimately, the concept of a train as a set number of physically coupled vehicles is fundamentally changed, as trains join and split dynamically during transit.

This capability enables train services to meet the projected growth in rail customers in an affordable way whilst simultaneously helping to meet growing customer expectations.

Initial development and deployment of moving block signalling reduces train headways. A new operational philosophy and safety case is required to close the gap between trains further. Development in remote and autonomous train control, predictable and dependable braking and traction systems, and faster and completely fail-safe route setting are all critical elements for this capability.

Standardisation of mechanical and electrical couplings, vehicle-to-vehicle communication technologies, and new approaches to vehicle crash worthiness are essential for the transition from convoy operation to virtual, and then optionally mechanical coupling during transit.

To fulfil the capability, the driving task is completely automated and traffic regulation is fully optimised for additional capacity and connectivity.

Predictable braking

The Predictable and Optimised Braking programme is aimed at providing consistent and safe braking systems that function in all weather conditions. This capability is not only important on its own, but also an essential forerunner to future rail traffic management systems and an enabler for running trains closer together to increase capacity.

Different solutions are being investigated, including: new ways to manage the condition at the wheel rail interface; novel braking systems; and the management of braking efficiency by blending together different braking systems.
Minimal disruption to train services

- Real time monitoring - internet of things
- Plug and play
- Eye in the sky (satellite/drones)
- Maintenance robot
- AI supported decision making
- Railway data bus

- Performance based specifications and supplier services
- Modular replacement parts / repair in place
- 20:08
Minimal disruption to train services

High availability of infrastructure and rolling stock assets is essential for the railway to meet the requirements of passengers and freight customers. With an increasing demand for rail journeys, it is necessary to maximise the reliability, availability, and maintainability of the system.

Asset health is monitored in real-time through an array of smart built-in sensors, which are connected together in an Internet of Things. Aerospace assets provide additional visual and geographical information about the infrastructure and rolling stock.

Real-time asset intelligence uses machine learning and big data analytics to translate condition data into preventative maintenance plans. To ensure maximum availability of the railway system, the maintenance plans are scheduled automatically, and any identified repair work is carried out before the asset fails.

Modular, line replaceable units simplify maintenance and repair, and the greater use of robotics and automation increases maintenance output as well as minimises hazards to railway staff. A diverse supply chain assures the punctual delivery of high-value parts.

The first priority for the railway is to establish the information architecture and integrate existing asset management systems to create comprehensive whole system asset management solutions. To share data effectively, asset owners need to establish data sharing principles and build a common architecture for sensor communication.

Track system innovation

A series of projects covering research and innovation into track structures and substructures led by Network Rail covers areas such as ballast, switches and rails.

The programme encompasses all of the work that the infrastructure manager is currently undertaking into track improvements, including the wheel-rail interface and improving the stability and reliability of the track support components. These include:

- Investigations into adhesion on wet rails
- Innovative asphalt track to replace ballast
- Micropiling to improve the stability of current track formations
- Modular slab track to reduce the depth of track formations under bridges

Milestone A
Full RCM potential

Milestone B
Smart assets deployed

Milestone C
Guaranteed asset availability (peak time)

Milestone D
Support activities scheduled by AL

Milestone E
100% Enterprise availability (peak hours)
Efficient passenger flow through stations and trains

Stations need maximum efficiency to increase the throughput and turnaround of passengers and trains safely. For many passengers, use of the railway is part of a longer journey, which may involve different forms of transport. Station, platform, and train access is a principal contributor to the customer experience and to reduce the railway’s carbon footprint.

Improved accessibility at stations is essential for the railway to be part of emerging trends in intelligent and integrated mobility solutions. Passengers who arrive at the station in private transport are directed automatically to the nearest available parking facility. Those who are leaving the station have a variety of transport solutions for their onward journey. These transport options are scaled to meet the predicted demand.

At large hub stations, smart management of passenger flows minimises congestion and bottlenecks. With the use of electronic ticketing and smarter solutions to validate passengers’ permission to travel, existing bottlenecks, such as gate queues and ticket halls, are removed. The full length of the platform is accessed easily. Passengers boarding and alighting are segregated, and nudging techniques are used to influence passenger behaviour. Improved technologies for finding directions are provided.

Reliable braking technologies allow trains to approach a platform at greater speed and stop precisely. Any time delay between the train stopping and the doors opening is reduced or removed with lighter, faster-opening train doors open as soon as the train has stopped.

Removing ticket barriers

Ticket gates help to protect the railway from lost revenue by deterring customers from avoiding fares. However, barriers also have an impact on passenger throughput at busy stations and make accessing the railway more difficult.

Advances in wireless technologies, image processing and biometrics provide the opportunity to rethink the ticket barrier. Changing physical barriers for electronic gates that can determine a passenger’s permission to travel without the need for any interaction on their part, has the potential to create a truly walk up and walk on service. The Future Ticket Detection programme is exploring these technologies and is taking three alternative approaches to revenue protection through to demonstration.
More value from data

- Information governance
- Capture, store and manage data
- Exploitation of new data driven revenue streams
- Allow easy access to data
- Cyber security
- Architectures and protocols
More value from data

The effective management of information is vital to the railway enterprise and underpins the delivery of the other eleven Key Capabilities. Rationalising the myriad information sources and systems in the railway will require a deep understanding of the information the railway collects and how this is used by the different parts of the industry.

An industry wide information architecture and information governance structure will coordinate information needs and establish a means of supplying these. Information will be shared across the industry and more widely enabling the development of new services and applications to the benefit of the railway and its customers.

Data collection will be rationalised, reducing industry costs. Standards will allow information to be interpreted and combined more easily delivering new insights and intelligence to the industry. Ultimately data collection, analysis and interpretation will be automated and occur in near-real time providing consistent and robust information to a network of interconnected systems and applications enabling better informed decisions to be made faster.

Open data and data analysis

The decision by Network Rail and National Rail Enquiry Services to provide a range of railway data feeds to software developers is a welcome step that has already started to deliver benefits to railway users via applications such as ‘real time trains’.

Within the industry train operators are looking to innovation to yield increased value from their data. One project aims to gather incoming operational data into a ‘data warehouse’ where it will be automatically analysed and interpreted to provide real-time and in-depth performance reporting tools.
Optimum energy use

New approaches to meet the energy requirements of the railway system are needed for an increasing number of higher frequency services on major routes.

Optimised on-board and lineside energy storage technologies allow the railway to move energy around the system according to the supply and demand. A higher proportion of energy is recovered through regenerative braking, and small-scale energy generation and harvesting technologies feed energy-efficient trackside systems.

Conventional approaches to electrification are unsuitable for low-traffic lines. A more holistic approach, which makes better use of energy generation and storage technologies, drives down operational costs and reduces the railway’s carbon footprint.

Hybrid operation on new powertrains uses electric traction to run beyond the portion of the network with overhead electrification. The same technology allows for discontinuous electrification at stations and on branch lines, which dramatically reduces the capital cost of extending electrification to more parts of the network.

The initial focus is to lower the costs of conventional electrification and develop innovative powertrain and energy storage solutions for rolling stock.

Modelling the railway energy system for optimisation leads to the development of smart energy solutions for the railway.

Reducing the cost of electric traction

Electrically powered trains have many attractive qualities including lower running costs, improved performance and reduced noise and air pollution for passengers and those living and working near the railway.

However, the capital costs of electrifying the railway are considerable. A range of existing industry innovation projects are looking at: technologies and techniques for avoiding costly reconstruction of bridges (currently approximately one third of the cost of electrification) to accommodate overhead lines; and removing the need for continuous electrification along a route by providing energy storage on the train as exemplified by the successful trial of a hybrid battery-electric train.
More space on trains

- Effective luggage systems
- Potential for double decker
- Train subsystems miniaturised to generate more usable interior space
- Moveable flexible interiors
- Bigger trains
- Infrastructure gauge clearance
More space on trains

A significant factor in the utility of a train is the amount of usable space on the vehicle and the way in which this space is used to the benefit of customers, both freight and passenger.

Increasing the amount of available space, in real terms, requires a better understanding of the constraints imposed by the rail infrastructure i.e. the space envelope created by bridges, tunnels and platforms and how this can be increased at low cost, as well as clever placement, and size reduction, of rolling stock sub-systems to increase the usable interior space.

The ability to quickly and easily reconfigure the interior of passenger trains, either during normal daily operation or at key points during the vehicle’s service life, can provide greater flexibility as the demands of passengers change either throughout the day or gradually over time.

For freight trains the ability to adapt freight wagons for a variety of load types and sizes increases the utilisation of freight wagons, reducing costs and increasing flexibility.

A means of valuing the unit benefits of a vehicles interior space is fundamental to the development of this capability since improvement will come from the combination of several marginal gains. This will focus development work and provide incentives for less conservative vehicle specification - presently vehicles are commonly specified to fit down the most restrictive routes to ‘future proof’ their deployment.

Transforming train interiors

Providing greater flexibility in the interior configuration of trains has the potential to improve customer experience and provide new revenue generating opportunities that capitalise on the strength of the railways high frequency operations and city centre to city centre network.

The Tomorrow’s Train Design Today programme challenged designers to develop vehicle concepts and flexible interior spaces. One innovative project explored the feasibility of a passenger carriage where the seats could be pushed up together during off-peak times to make room for purpose built freight containers carrying lightweight high-value goods.
Services timed to the second

- Automated recovery from perturbation
- Exact positioning
- Constantly monitored
- Dynamic timetables
- Automatic vehicle identification
- Greater situational awareness
- Customer insight
Services timed to the second

Greater flexibility of operation, improved recovery from disruption and precise scheduling of trains requires trains to follow a prescribed motion path.

Every train should be in the right place at the right time travelling at the right speed. This is not to say that the setting of a train’s journey profile should be rigid, instead known and reliable train performance, and the ability to determine the precise locations of trains, will enable greater flexibility in the delivery of services.

As network capacity increases and greater connectivity is sought greater precision in the position and timing of trains will be required. Greater precision will also help to deliver fresh insights into why trains are out of position. This will improve the industry’s understanding of small perturbations to train services and how best to manage these to minimise any knock-on effects.

Recovering from perturbation to the desired journey profile, including recovery from major disruption, will require automated rescheduling of services to recover the service provision in a controlled and managed way.

Train positioning innovation

An open innovation process was used to develop novel technologies for accurately locating trains on the rail network. A range of technology solutions were developed.

One solution included the use of a camera to video the track and, through image processing, determine the precise distance travelled and which track the train is on. This technology can deployed to overcome the limitations of satellite based positioning solutions, which struggle to provide accurate positioning in cuttings and tunnels.
Intelligent trains

Increases in computational power and advances in communications, automation and sensing provide the railway with the opportunity to develop and deploy intelligent rolling stock.

Intelligent trains will reduce the reliance on complex and expensive rail infrastructure and control systems and through automation transition the role of railway staff from direct control and operation to supervision.

A network of fully intelligent trains will be self-regulating, negotiating vehicle to vehicle to resolve movement authorities and potential conflicts at junctions in the network. Intelligent trains will be able to operate in a fully autonomous mode under remote supervision.

In the near term, train signalling can be transferred from the infrastructure to the rolling stock using mature technologies e.g. ETCS level 2. However, given the pace of development in Information and Communications Technology a completely new operational concept and train control and regulation capability can be developed over the short to medium term.

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Applying automotive principles to trains

Trains use bespoke, and often incompatible, on board systems that operate in isolation from one another. This makes it difficult to develop new functionality and features by interfacing with existing systems.

One project is looking at the development of a ‘Processing Node Controller’ which, when placed on a train, is capable of running a number of applications whilst also sharing information between on board systems. In concept this is similar to the system-wide controllers used in the automotive industry, which have resulted in cars with greater functionality, more redundancy and improved reliability.
09 Personalised customer experience

Intelligent 2-way communication with customer

Smart mobile ticketing

Seamless modal interchange and intelligent mobility

Virtual concierge

Biometric permission to travel
**Personalised customer experience**

Customer focused design of the railway, in terms of the railway environment and the service provided by rail operators, is central to the RTS vision.

Developing a deeper understanding of customers, both freight and passenger, is required if the railway is to play an active part in providing mobility to an increasingly connected customer base.

A physical ticket will not be required to access the railway. Individuals will be automatically identified and the appropriate charges levied against their travel account. Machine learning will be used to understand passenger trip characteristics and provide real time guidance to individuals to improve their journey based on an understanding of their preferences. The railway service will be more flexible: responding dynamically to changes in customer attitudes and behaviours.

Initially the phasing out of cardboard tickets to be replaced by electronic tickets (already in use on certain parts of the network) will greatly improve the flexibility of ticketing and provide a richer picture of travel patterns and demands.

A step change in the information feeds provided to the public will be needed. Information such as how busy different services will be and what amenities are available on each train as well as precise real time information of the service will enable customers to make informed choices about their journey. Customer preference data can then be used by the railway to influence customer choices and shape the service provision to better meet customer’s expectations.

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**Guiding passengers to available seats**

Being able to get a seat on a train features prominently in the feedback from customer surveys. Technologies are being deployed that can help passengers improve their chance of finding a seat on a busy train by measuring the occupancy of the carriages in real time and using information on boarding alighting patterns to determine where space will be available. This information can then be provided to customers via a smart phone app or through the use of dynamic platform signs.

The same technology could be used to manage train dwell times more effectively by encouraging more even boarding and alighting patterns at busy stations.
Flexible freight

- Self assembling consists
- New freight hubs
- Flexible train systems
- Flexible interiors for light freight
- Next generation logistics
- Better wagon design
- Reducing freight costs
- Freight handling automation
Flexible freight

The development of new rail freight markets to work alongside traditional bulk haul and containerised rail freight has the potential to improve the range of logistics products and services that the railway can offer.

The frequency of rail services, and the location of stations in urban centres, means that rail has the potential to play an integral part in a time sensitive logistics solution.

A wider variety of freight will be shipped by rail using improved scheduling, routing and tracking capabilities to ensure that the railway can integrate fully with intermodal freight and services new markets for light packet high value goods.

Freight wagons will be designed to be flexible, as far as is reasonably practicable, to increase the variety of loads that can be hauled and maximise wagon utilisation. Modal interchanges will be automated allowing freight to be transferred quickly and efficiently for onward transit.

Freight solutions which work in tandem with passenger services open up new freight markets for the railway providing a reliable, high speed and energy efficient alternative to road freight.

Mobile freight consist app

Freight trains are checked prior to dispatch and detailed information on the train consist is recorded. Until recently this process required an operative to write down the consist information and fax the resulting document to a clerk for input into a computerised system.

A Mobile Freight Consist application has been developed to speed up the consist recording task. The application runs on a tablet computer allowing an operative to record the required information electronically and upload it directly to the central system. In addition to improving efficiency the more simplified workflow reduces the number of transcription errors.

In the future the information recorded in the Mobile Freight Consist application could be fed directly into other railway information systems, unlocking further value from the data.
Low-cost railway solutions

Using the rail corridor to support the rural economy

Low cost energy solutions

Simplified lightweight low cost rolling stock

Low whole life cost of operation
Low-cost railway solutions

Driving down the cost base of the railway is important nationally, but especially so for areas where demand is light and revenues are low. The mainline, heavy, rail network has a significant cost base both in terms of the initial capital investment required to establish a route and the ongoing operational expenditure.

The low-cost railway will adopt ideas and technologies from the light-rail sector (and other sectors such as automotive) and integrate these with mainline rail requirements.

Light-weight energy-efficient rolling stock with minimal lifecycle costs will deliver services using appropriately designed track infrastructure, energy systems, and command and control systems.

In addition to improving the business for existing routes the capability will allow for improved business cases for future network expansion.

Opportunities to optimise the operating costs of the existing network and rolling stock should be explored in the near term with more radical solutions for cost reduction deployed as these become available.

Where appropriate, low-cost solutions developed on the light demand parts of the network (where the risk to operations is low) can be transferred to more heavily trafficked parts of the mainline network.

Very light rail vehicle

Innovative rolling stock solutions have the potential to drive down the cost of branch line operations by providing a new breed of vehicles that are light weight and low cost. The Very Light Rail Vehicle project is designing, building and testing a low-carbon lightweight railcar.

The vehicle uses innovative interior packaging appropriate to shorter distance, and relatively low-speed, operations typical to UK branch lines. Core to the design is the development of a self-powered, self-contained, bogie that includes all of the traction and braking equipment within the bogie frame. Pairing this bogie with a lightweight body results in a modular train design that is significantly lighter than conventional diesel multiple unit vehicles.
Accelerated research, development and technology deployment

- Centres of excellence
- Innovation maturity
- Supply chain collaboration
- Technology pipeline: continuous and uninterrupted
- Accelerate decision making
- Investment in R&D
Accelerated research, development and technology deployment

Enabling technologies to be more readily and rapidly integrated into the railway system will ensure that society benefits from innovations in a timely manner. Such rapid deployment requires a systematic building of innovation and integration capability at industry level to ensure barriers to the adoption of new technology are removed.

Presently the routine consideration of technology, as a necessary part of any project, is limited. This stifles demand for R&D and increases the risk for suppliers developing new products and services for the railway. Incentivising private sector investment in railway technology needs a consistent approach to the consideration of new technology in industry planning for major projects and enhancements.

Accelerating the pace of technology development requires senior level sponsorship of the Key Capabilities within this plan and a suite of tools and facilities to help connect suppliers with railway customers. The critical success factors are:

- **Strategic alignment** - Articulating a clear innovation strategy that is aligned to transport strategy.
- **Collaboration** - Efficient sharing and protection of data across organisational boundaries.
- **Competitive Environment** - Ensuring contract durations match innovation development timelines and investment horizons.
- **Innovation Processes** - Ensuring suitable specifications and standards are in place to focus innovation across the value chain.
- **Organisation** - Clear decision making processes around industry-wide innovation initiatives and industry facilitating risk-sharing business models.
- **Culture** - Industry behaviours focused on the end customer; actively encourage thoughtful risk and opportunity taking.

Test track development

Bringing new technologies to the operational railway requires them to be tested in a safe and representative environment. The UK has a number of test track facilities with a wide range of capabilities and demand for these often exceeds the available capacity.

The Rail Innovation Development Centres at Melton and Tuxford are able to test new and modified trains, infrastructure and equipment. Developments at Melton have unlocked additional capacity by optionally splitting the track into two separate test sites and further enhancements have increased the range of testing that can be carried out.

The Rail Alliance test facility at Long Marston incorporates a 4km test track loop. In recent years the Rail Alliance have operated a testing voucher scheme that has provided subsidised access to the facility for small and medium scale enterprises.
Delivery

Delivering the twelve Key Capabilities into the railway will require an increased level of industry collaboration and strong leadership.

Effective collaboration starts with a common understanding of the aims and objectives. Industry experts were consulted in the development of the RTS and the Capability Delivery Plan and there is consensus on the RTS Vision and Outcomes. However, further effort is needed to establish the best collaborative delivery models across the industry.

The Technical Leadership Group (TLG) owns the RTS and will be accountable for leading its delivery. TLG reports to the Rail Delivery Group and the Rail Supply Group and has representation from across the rail industry and supply chain.

In addition to Technology Development, led by TLG, the Innovation Leadership Group (ILG) will lead on fostering a culture of innovation within the railway, picking up on some of the major themes in Key Capability 12, which will help innovators to bring new products and services into the railway.

Opportunities for technology development

An intelligent approach to the development of technology that recognises the strengths of the supply chain and leverages opportunities from investments in other countries and sectors is needed.

Some of the underlying technologies needed to deliver the RTS are at a high technology readiness level, in other industries and sectors. For example, the automotive industry has made significant investments in the development of autonomous and connected vehicles. Opportunities to capitalise on suitable transferable technologies from adjacent sectors must be taken up and support provided to bring these technologies across into the rail market.

Within the rail industry there are existing technology development programmes, including the European Shift2Rail programme which has, within its Multi Annual Action Plan, a range of proposed technology demonstrators which support the delivery of the RTS Key Capabilities.

In the UK the Rail Supply Group’s Industrial Strategy (Fast Track to the Future) sets out the five key rail technology areas where the UK has the potential to be a world leader. Here a case for domestic investment can be made as developing these technologies in the UK has the potential to deliver benefits to the railway and generate economic growth within the UK.

Keeping sight of all of the relevant existing technology developments will be key in identifying where the emerging technology and capability gaps are. To facilitate this, an online repository of RTS programme information has been created. This ‘model programme’ structure will be monitored and updated overtime as new thinking emerges enabling TLG and others to make informed investment decisions.

Complementing the RTS programme information, an online repository of supporting research and technology demonstration projects has been created to showcase existing technology developments from across the industry. This can be accessed on the SPARK website - an international portal for rail research and technology.
Routes to technology deployment

Deploying new technology into the GB railway is a significant challenge because the industry uses a set of rules and regulations designed to provide a degree of uniformity across the network, which has helped to create one of the busiest and safest railways in the world.

Meeting this deployment challenge will require innovation in the way in which the railway plans and procures major projects and franchises going forward. The good news is that there are already a number of initiatives, which signal a desire to bring new technology through to deployment. For example:

- In rail franchising the creation of the ‘Innovation in Franchising’ pilot in three recent franchises provides a mechanism whereby operators are encouraged to reinvest in the trialling of new technology on the operational railway.

- The Digital Railway programme, led by Network Rail, is pioneering a whole system approach that will bring together network operators, train operators and suppliers in the deployment of digital signalling systems.

Applying the lessons learnt, through the Innovation in Franchising pilot and the Digital Railway programme to the delivery of the RTS as a whole will be essential. Going forwards there will be further opportunities through network enhancements, rolling stock procurements and future franchises to develop new avenues for technology deployment.
Bibliography


Further information

More details of the Rail Technical Strategy, the Capability Delivery Plan, and associated programmes can be found on the RTS website:

www.rssb.co.uk/rail-technical-strategy

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