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Digital Railway has one goal:

Sustainable growth of Great Britain’s economy by accelerating the digital modernisation of the railway. This brings forward transformational benefits in safety, capacity, cost, performance, customer convenience and positive environmental impacts.
Which is realised through meeting three objectives:

1. **MORE TRAINS**
   
   more space for more trains, enabled by modernising Victorian-era block signalling with digital train control, enabling trains to run closer together on the existing infrastructure.

2. **BETTER CONNECTIONS**
   
   more flexible rail timetables able to respond effectively to changing patterns in passenger and freight demand, enabled by modernising timetable design and managing traffic in real-time.

3. **GREATER CONVENIENCE**
   
   customers access information and ticketing services that work across all modes of transport, via web and mobile device apps, enabled by an industry-wide open data approach.
Achieving break-through outcomes for GB rail in:

1. **Capacity**
   - Up to 40% more capacity where it is most needed, delivered at c.30% lower cost than conventional line construction
   - Larger number of reliable train paths, enabling more people to travel and more goods to be transported
   - Improved performance as a result of reduced headways
   - Faster recovery from faults when they occur
   - 35% reduction in primary delay caused by signalling asset failures
   - A safer railway. 80% fewer Signals Passed At Danger (SPADS), less track-side work

2. **Flexibility**
   - Agile timetabling to optimise supply to meet demand – incl. freight / passenger mix.
   - Reduced journey times through better connectivity
   - Better connected inter-modal freight nodes
   - Fewer line closures by exploiting bi-directional network capability
   - Scope for turn-up-and-go metro-style services
   - Optimised train management during disruption

3. **Open Data**
   - An open data approach to rail information enabling accelerated
     - Clear real-time multi-modal journey planning information
     - Helpful information during disruption
     - Intelligent guidance from one mode to another
     - Electronic ticketing with open interfaces for ticket/token validation
     - Greater scope for service differentiation
The case for accelerating a digital railway

We need a transport network that connects skills to jobs, and goods to markets at home and abroad. At the same time, we need to keep pace with challenging public expectations about the quality, choice and value that public services should provide.

Four key challenges stand in the way of this ambition:

- To provide significant additional capacity and better performance on increasingly overcrowded parts of the network.
- To increase the flexibility and connectivity of the railway so that the right train service is available at the right time, with flexibility to make short-notice changes that better match supply with demand. Modern freight services should be as agile and dynamic as the modern supply chains of which they are a part.
- To improve end-to-end customer experience of the railway system – from simplifying the purchase and authentication of tickets for end-to-end journeys to providing real-time flexibility for how and when they travel.
- To reduce the operating cost of the railway whilst further improving safety, and make optimal use of existing assets rather than building new ones.

These challenges must be addressed on a rail industry-wide basis.

Background to the Digital Railway programme

Digital Railway is a rail industry-wide programme designed to benefit Great Britain’s economy by accelerating the digital-enablement of the railway.

Initial analysis has established that:

- We can move substantially more people and goods on our existing railway footprint. Digital train control enables an increase in traffic on our existing railway by up to 40%.
- We can provide extra capacity at less cost. This additional capacity can be provided at a cost 30% less than building new lines to deliver equivalent train path throughput.
- We can operate the railway at reduced cost. A digital railway is less costly to operate than a conventional one.
- We can collaborate to benefit our customers. There are a number of customer facing digital programmes underway across the industry; the programme has a real part to play in putting key enablers in place for these initiatives to improve customer experience and convenience in a more coordinated manner, underpinned by an open data approach.
- The basic technology required to deliver this change is available today.
Objective 1: More Trains
The UK is struggling to keep pace in adding the rail capacity it needs to connect people to jobs, and goods to markets at home and abroad.

Parts of the UK’s railway system are already operating above designed capacity at peak – in some cases services are crowded by up to 200%.

This challenge to sustainable growth will become even greater in years ahead: passenger numbers have increased by 43% in the last decade, but are set to double again in the next 25 years. We need to enable our infrastructure to deliver to a billion more passengers in the next 30 years.

Freight demand for intermodal shipments, driven by an explosion in e-commerce, has increased by almost 100% since 2003.
Complication: adding new capacity is slow and disruptive

Not only is conventional construction costly and disruptive but we are being short-changed in our investment in capacity because of the deep inefficiencies of the signalling technology we have inherited from the Victorians.

As each signalling project is highly specific to the local landscape, they are expensive, complex and lengthy undertakings. We spend £3bn every five years just to maintain existing signals.

And when the work is done, we are left with a significant physical infrastructure that is expensive and complex to manage.

- Land purchase for adding extra tracks is expensive and often contentious.

- More capacity is most needed on commuter routes into major cities, where space is at a premium

- Major construction-based modifications are highly disruptive to existing services.
The key question for policy-makers and industry is how to make today’s infrastructure more productive. To answer this, we need to look at the biggest constraint: the block-signalling system, which limits capacity. A failure to reform this Victorian legacy will result in ineffective use of current assets and sub-optimal returns from future railway investment.

**An introduction to signalling on today’s railway**

- The railway is divided up into signalling sections, or ‘blocks’. The signalling system keeps the railway safe by only allowing a train into a block section after the preceding train has vacated it.
- This maintains a safe distance between trains, but makes inefficient use of the railway infrastructure. This inefficiency isn’t a problem if there are plenty of spare blocks between trains so they can keep moving on a wave of green lights, but once the railway fills up trains have to move in lock-step as they wait for blocks to be vacated; a small delay to one train can cause massive knock-on effects.

**Headway**
- Signalling imposes greater headways than required

**Start/Stop**
- As capacity nears its maximum, start/stop signalling introduces bunching and degrades operating performance.

**Sighting**
- Signal sighting distances are important and often result in artificial speed limitations
In the UK today, it is rare for train paths and speeds to be controlled automatically. Instead, traffic is controlled through a mix of systems, chiefly based on ‘fixed block working’ delimited by physical signal locations. However, a digital approach is able to remove the fixed block constraint altogether.

**The Digital Railway**

- A digital approach introduces a command and control system that creates a safety buffer zone around trains, which is informed by trains communicating their position in real-time, where the buffer zone moves with each train effectively forming a ‘moving block’ safety envelope around it. Appendix A describes this technology in more detail.

**Reliability Benefits**
- 35% reduction in primary delay minutes
- Reduced requirement for construction work

**Capacity Benefits**
- Up to 40% increase in train path capacity demonstrated in Wessex route study
- Bi-directional at minimum cost

**Safety Benefits**
- 80% reduction in trains passing red signals
- 50% reduction in trackside signal and control system maintenance

**Environmental Benefits**
- Eliminating start/stop reduces equivalent energy consumption by 15%
Air Traffic Control

An example of a safety-critical transport sector that already has become digitally enabled, is aviation. It has:

- Digital air traffic control
- Collision-avoidance with autopilot
- Electronic ticketing
- Optimal allocation of runway capacity
- Yield management in journey sales
- Interoperability between air traffic control over different countries

Digital air traffic management has released over 60% of new capacity.

A combination of Autopilot – a collision-avoidance safety system – and Air Traffic Control, a digital traffic flow optimisation system – has enabled the aviation industry to make far more effective use of runway capacity. This chart represents what was achieved at Heathrow airport over a 50-year period:
In the past year there was a 3% increase in the number of LU passenger journeys and the London population is expected to increase by 1.4 million by 2030. The old signalling struggled to provide the necessary capacity increases.

The Victoria, Jubilee and Northern Lines have all installed new Automatic Train Operation (ATO) systems and use new control centres.

More trains running on the upgraded lines, resulting in up to 60% increase in capacity.

Energy consumption reduced by up to 30%.

Estimated drop of 50,000 hours in customer delays as a result of remote track-circuit monitoring.

Major investment is now being delivered in a smart motorways programme that utilises Digital technology to monitor incidents, communicate real-time instructions to drivers, and open the hard shoulder when needed.

Data from pilot programmes confirms:

- 22% improvement on journey times.
- 55.7% reduction in incidents.
- M1 and M3 schemes projected to deliver 33% extra capacity.
- Significant environmental gains.
More Capacity

Up to 40% more capacity, enabling more people to travel and more goods to be transported.

Larger number of reliable train paths, 24x7, based on bi-directional network.

Improved performance as a result of reduced headways.

Faster recovery from faults when they occur.

35% reduction in primary delay caused by signalling asset failures.

A safer railway. 80% fewer SPADS, less track-side work.
Objective 2: Better Connected
As the significance of our metropolitan centres increases, flexibility and connectivity in rail transport becomes a critical enabler for UK success.

With more and more people are living in cities and suburbs, commuting patterns connecting people with places of work have become more complex. Our cities’ success demands the flexibility and connectivity to meet the complex commuting and leisure transport patterns of urban and suburban populations. But as our railway was designed to move people into city centres, supply is increasingly mismatched to demand patterns.

Key facts: Growth in Urbanisation

- The world is urbanising. 62% of GDP growth in the next decade is projected to come from cities.
- In the UK, our Core Cities grew by 9.6% in the last decade against overall population growth of 7.6%.
- Today, nearly half of UK households live within our 15 largest metros, each home to at least half a million people.

Inflexibility in the system limits ability to respond to unanticipated incidents.

Instead of being able to respond to incidents in an agile way, the current levels of inflexibility in the system exacerbates incidents when they occur. This contagion effect causes delays for passengers and creates an unpredictable and unreliable service.

When things go wrong, disruption spreads far beyond where it started – sometimes over the course of a whole day.
Complication: poor demand visibility, inflexibility

- Today’s train planning is limited by poor demand visibility, little information sharing in the industry, and little insight relating to how passenger demand is changing at a localised level.

- Freight is developing an even further misaligned demand profile; the railway timetable includes many empty freight paths, historically held for coal and aggregates shipments, yet coal shipment is in decline and e-commerce demand is growing exponentially. This mismatch represents inefficient allocation of a scarce capacity resource.

- Timetabling is a sophisticated product, built 2-4 years in advance. The process employs around 300 skilled train planners, who design timetables using train graphs that illustrate how traffic weaves together.

- The tooling the train planners use is digital, but timetable design is a manual effort involving plenty of negotiation, recognising specific service obligations built in to franchises and other constraints defined through ‘grandfather rights’.

Train planner

Semi-automated planning: the Train Graph
Question: how do we make services more flexible?

Four barriers to greater flexibility and better connectivity:

1. Visibility of journey demand and how it is changing is poor.
2. The timetable design process is lengthy, with limited decision-support.
3. Once designed, the timetable is rigid. Processes to request even minor variations are heavily bureaucratic and require several days notice.
4. Operational processes are unable to manage truly ‘on demand’ services, especially for freight.

Case study: Insights from Oyster card data

Four opportunities to create flexibility and connectivity

1. Demand analytics supported by policy change.
   Better planning requires better demand data, based on an anonymised open data approach:
   - Season ticket information
   - Information captured at the gate-line or its future equivalent
   - Mobile operator data showing end-to-end journey patterns and how they are changing

2. Greater franchise flexibility supported by policy change
   - More flexible services require fewer specific and often restrictive obligations in service provision, enabling a more flexible approach to timetable development and demand fulfilment

3. Digital planning tools
   Better timetables require more sophisticated design and planning tools, based on an accurate railway information model, enabling greater focus on delivering journey connectivity as well as point-to-point train running.

4. Technology, skills and processes
   Flexibility to accommodate service changes requires traffic management, rostering and modernisation of working practices, to deliver a responsive railway service capable of dealing quarterly, monthly, weekly and on-the-day demand variations.

In-cab Driver Advisory systems linked to train control to optimise and smooth the flow of traffic.
Better Connected

Agile timetabling to optimise supply to meet demand – incl. freight / passenger mix

Reduced journey times through better connectivity

Better connected inter-modal freight nodes

Lots of people going to Milton Keynes this afternoon...

Scope for turn up and go metro-style services

Optimised train management during disruption
Objective 3: More Convenient
Situation: information is insufficient, ticketing is inflexible

Customers need and want to make informed choices about travel

Customers expect to be able to plan journeys and make personalised, context specific, multi-modal journey plans with real-time guidance.

Data relevant to these value-choices is not being shared by the industry; information about crowding, seat availability, and carriage occupancy data matter to the choices people make about how they travel.

Customers expect to be able to act on information by exercising choice about journey options, with a great degree of flexibility – for example, through tickets that work across different modes of transport, and through the ability to upgrade tickets once on a train, change service options and seat reservations.

This simply isn’t possible with today’s transactional systems for ticket booking, seat reservation and payment.

% of journeys where passengers reported “pain points”

Without train Train only Multi-modal journey

58% 74% 86%

Paper tickets reduce scope for customer choice

Without train Train only Multi-modal journey

58% 74% 86%
Complications: commerciality, incompatibility

Two key constraints stand in the way of customers benefiting from more convenient rail services:

Whilst an increasing amount of rail-related data is available to support the development of better services that increase convenience for customers, the data landscape is incomplete. Information is fragmented and difficult for developers to join together. Real-time and historical data regarding journey comfort factors, such as crowding, seat availability, carriage occupancy are not openly available, yet this information is important to customers in making their journey choices.

Incompatibility between electronic ticketing systems is leading to increased fragmentation between different modes of transport in different regions. Whilst this might work well on a local basis, with successful schemes like Oyster and SEFT, a consistent transactional interface is required to those systems to enable retailers to offer integrated journeys on a national basis.
Question: how do we make services more flexible?

To answer this question we have to understand the constraints.

There are four primary constraints:

1. The pace of change of consumer-facing information applications and services development is considerable, so any approach taken must enable, rather than hinder, this.

2. Journey options are difficult to assess without train occupancy (comfort) data which is not openly available.

3. Digital ticketing systems are mainly proprietary to specific transport operators or owning groups.

4. Ticket purchase and seat reservation systems are inflexible and unable to support instant upgrades or late changes.

Answer: take an open-data approach to empower the apps industry to innovate the best solutions for all kinds of customers.

Open data supported by policy change.

An open data approach enables rail information to become fully integrated with other modes of transport:

- Journey option and timing data (timetable)
- Journey cost data (tariff data)
- Journey comfort data (occupancy data)
- Real-time operating data (including carriage occupancy)

Open transactional services, supported by policy change.

An open transactional interface approach enables third parties to access rail services in a consistent manner, making it easy to incorporate ticket booking, seat reservation, alternative forms of payment and late-notice changes into all kinds of different applications.

This is able to work across multiple types of ticketing sub-systems, creating the appearance of an integrated solution to the end-customer.
More Convenient

Clear real-time journey planning information

Helpful information during disruption

Intelligent guidance from one mode to another

Scope for service differentiation
Delivery: A Whole Industry Approach
Situation: current industry initiatives are fragmented...

**Current Digital initiatives**

- Train operator plans for rolling stock enhancement and Government plans for the next round of franchises are being developed independently. This risks creating the option for more capacity without creating the means to fulfil it.

- In parallel, a number of digital-enablement initiatives are underway – but these are not aligned to a coherent ‘end-state’ for the future digital railway.

**The risk of a fragmented approach to change**

- In this context, there is a risk that in 15 years, we have implemented fifteen different standards and approaches that fail to deliver the potential of Digital for the UK.
…with a ‘slow’ 50-year plan for digital-enablement

The current industry plan for deploying traffic management (which manages the overall flow of traffic) and converting from conventional to ETCS in-cab signalling (which manages individual trains for collision avoidance) runs for almost 50 years.

This plan was developed on the basis of replacing signalling equipment with a digital equivalent once it is life-expired. This delivers an optimum renewals case based on a lowest whole-life cost approach for signalling assets.

Digital Railway is taking a different approach, seeking to maximise economic benefit through an accelerated deployment of digital train control.
Digital Railway is taking a whole-industry approach...

The vision for a digital railway is not just an infrastructure challenge. A whole industry approach and solution is required to deliver the benefit. This includes:

- Investment by owners and operators in upgrading trains, in some cases replacing them with new traction and rolling stock, and re-skilling the workforce to deliver new more flexible working practices.

- Investment by the infrastructure operator in new communications, command and control, information and power infrastructure, and re-skilling operational and maintenance staff to work with digitally-enabled processes and tools.

- Investment by Government in changing the regulatory and franchising frameworks to put the necessary enablers and incentives in place to accelerate the pace of change.

- Investment by the supply chain in industrial-grade technology solutions and building the required skills-base to deploy them.
...which could deliver over a 15-year time-frame
Next steps: mobilising the Digital Railway

1. PHASE 1: In delivery
   - ETCS Level 2: Paddington - Heathrow
   - TM trial: Romford & Wales
   - First in Class: approx 20 classes
   - ThalesLink: Integrated ETCS & TM

2. PHASE 2: Toolkit developed by mid-2016
   - Business change & People plans
     - Culture change
     - Workforce
     - Skills
     - Resources
     - Training
   - Supply chain management
   - Pan-industry collaboration
   - GSM-R
   - Testing level 2 in one route
   - Route Plans
   - Initial Industry Plans
   - CP6/CP7
   - Pathfinder
   -.toolkit enabling repeatable, scalable rollout – e.g. addressing business change, supply chain management.
   - Availability of enabling technology and data – e.g. GSM-R specification, testing.

3. PHASE 3: 2019 – 2029
   - National rollout to level 3

Full Business Case
Our current focus is to deliver accelerator projects that enable scalable national delivery

**Business Case**

Full Green Book business case to confirm an agreed case for change, affordability, achievability and value for money

- Digital train control could enable interventions that increase in traffic on our existing railway by up to 40%.
- The additional capacity can be provided at a cost 30% less than building new lines to deliver equivalent train path throughput.

**Phase 1 Delivery**

- Traffic Management (TM) at Romford & Wales Rail Operating Centres (ROCs).
- Support for the introduction of TM by the Thameslink Programme.
- Deployment of European Train Control System (ETCS) on the Paddington approach to Heathrow, East Coast Main Line and Thameslink.
- Development of programmes such as C-DAS (Connected Driver Advisory System).
# Digital Railway Programme Steering Board

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<tr>
<th>Name</th>
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<tbody>
<tr>
<td>Mark Carne (Chair)</td>
<td>CEO - Network Rail</td>
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<tr>
<td>Paul Plummer</td>
<td>Group Strategy Director – Network Rail</td>
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<tr>
<td>Jerry England</td>
<td>Group Digital Railway Director – Network Rail</td>
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<tr>
<td>Tracey Harrison</td>
<td>Programme Manager (interim) – Network Rail</td>
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<tr>
<td>Andrew Wolstenholme</td>
<td>CEO – CrossRail</td>
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<td>Michael Roberts</td>
<td>Chief Executive – ATOC</td>
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<td>Richard Price</td>
<td>Chief Executive – ORR</td>
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<tr>
<td>Alistair Gordon</td>
<td>CEO – Keolis</td>
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<tr>
<td>Chris Burchell</td>
<td>Managing Director – Arriva</td>
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<tr>
<td>Terence Watson</td>
<td>Managing Director – Alstom</td>
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<tr>
<td>Clare Moriarty</td>
<td>Director General – Department for Transport, Rail Executive</td>
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<tr>
<td>Martin Griffiths</td>
<td>Chief Executive – Stagecoach</td>
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<tr>
<td>Patrick Bossert</td>
<td>Digital Transformation Director – Network Rail</td>
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<tr>
<td>Martin Arter</td>
<td>Digital Development Director – Network Rail</td>
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<tr>
<td>Jeremy Rolstone</td>
<td>Director, Infrastructure, Safety and Security -</td>
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