DIGITAL RAILWAY

The Digital Railway programme is the industry’s plan to tackle the UK’s capacity crunch. But what challenges does accelerating the digital modernisation of our railways bring? And how can these be overcome with good management, supply chain collaboration and a strong investment case?

October 2017

THE CAPACITY CRUNCH

Parts of the UK’s railway system are already operating at peak capacity, with some services up to 200% over-subscribed. Freight demand has also exploded, up 100% since 2003.

With passenger numbers set to double in the next 25 years, the benefits of digitisation have been much discussed. Wider modernisation could also benefit Network Rail, its passengers and freight in terms of network resilience, reliability and safety.

Momentum is gathering behind Network Rail’s Digital Railway programme. However, there are significant implementation challenges to overcome, centred around technology, as well as systems integration, co-ordination and collaboration of the supply chain, and making the business case for investment.

THE DIGITAL RAILWAY PROGRAMME

Network Rail has created Digital Railway in order to address capacity challenges in the UK network, and the need for modernisation of the railways. It is a co-ordination programme for cross-industry transformation, bringing together industry leaders and governing bodies, led by an advisory group that informs and sets direction.

The goal of the Digital Railway programme is the sustainable growth of the UK economy by accelerating the digitalisation of the railway. This will bring forward transformational benefits in safety, capacity, cost, performance, customer convenience and positive environmental impacts.

Digital Railway will touch almost every aspect of train operation, passenger experience and rail infrastructure, centred around the programme’s three main objectives:

• **More trains** - More space for more trains, by modernising the Victorian-era block signalling with digital train controls, enabling trains to run closer together on existing infrastructure.

• **Better connections** - More flexible rail timetables able to respond to changing patterns in passenger and freight demand, enabled by modernising timetable design and managing traffic in real time.

• **Greater convenience** – Customers can access information and ticketing services for all modes of transport via web and mobile apps, enabled by an industry-wide open data approach.

Network Rail is seeking to maximise economic benefit through an accelerated deployment of digital train control. The programme covers:

• Re-signalling and digital train control, most notably through European Train Control System (ETCS), to run trains closer together and improve capacity.

• Development of intelligent trains and infrastructure to improve monitoring of trains and data collection, as well as to reduce unplanned maintenance costs.

• Modernisation of passenger information and rollout of smart ticketing, leveraging the data to improve outcomes for passengers and freight.
There are many inherent challenges for the Digital Railway programme, not least the complexity of the Victorian-era signalling network and the variety of stakeholders to coordinate.

The diversity of traffic (varying types of passenger, freight) poses a challenge in making modernisation work for everyone. To overcome this in a co-ordinated and considered manner, a phased programme has been developed to deliver Digital Railway by 2029. This will reduce deployment risks while providing time to develop technology which can maximise the economic value of the Digital Railway programme.

**TECHNOLOGIES**

The initial focus will be on digital in-cab signalling to expand capacity and the technology necessary to support it.

Digital Railway will develop the specification of the system in conjunction with the supply chain to avoid technology lock-in and being tied to one supplier. It is also essential that a common communication protocol be developed. Without one, Network Rail will always have to manage and collate the data, and opportunities for leveraging valuable insight could be lost.

**European train control system (ETCS)**

ETCS is a scalable digital signalling technology which allows more trains to run safely on a given stretch of track. It is the principal technology needed to expand capacity of the railway. It will see traditional line-side railway signals replaced with a computer display inside train cabs.

Key characteristics are:

- **Automatic train protection (ATP)** ensures trains operate within safe limits and speeds. Cab signalling provides safe-movement authority directly and continuously to the driver through cab desk display.
- **Gives movement authority to a train**, allowing a maximum point to progress to safely, given occupation of the line by other trains ahead, and setting the speed accordingly.
- **Permits the driver to drive the train but, should distance or speed limit be exceeded or in danger of being exceeded**, then ETCS intervenes to control the train, bringing it to a standstill if necessary.

<table>
<thead>
<tr>
<th>Phase 1: Configuration strategic pilots</th>
<th>Phase 2: Technical integration and core business change</th>
<th>Phase 3: National rollout to ETCS Level 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trails of the technology, including:</td>
<td>Bringing the industry together with pan-industry collaboration</td>
<td>Toolkit enable repeatable, scalable rollout</td>
</tr>
<tr>
<td>Traffic management trial: Romford and Wales</td>
<td>Toolkit development leading to development of route plans, and initial industry plans for next control periods</td>
<td>Rolling stock will gradually be upgraded to ETCS Level 3 as legacy stock expires.</td>
</tr>
<tr>
<td>ETCS Level 2: Paddington - Heathrow</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thameslink: Integrated ETCS and traffic management</td>
<td>GSM-R specs and testing</td>
<td></td>
</tr>
<tr>
<td>Pathfinder - testing level 2 in one route</td>
<td>Data collection, cleansing, integration</td>
<td></td>
</tr>
</tbody>
</table>
Global system for mobile communications – railway (GSM-R)

GSM-R ensures digital, secure and dependable communications between drivers and signallers using radio technology. It will form the backbone of any ETCS system in the UK. However, the diversity of data it can support is limited and there are challenges ensuring coverage, so infill sites will be needed to ensure dual coverage. Advanced systems are being considered to overcome this, such as Long Term Evolution with a 4G service. These are some way off being ready to use.

Traffic management (TM)

Where ETCS allows more trains on the tracks, the traffic management technology maximises performance by allowing trains to run together as effectively as possible. The traffic management software allows real-time train planning to cope with short notice needs or disruption, as well as allowing more flexible timetables to cope with school holidays or other annual changes in demand.

Automatic Train Operation (ATO)

To support drivers in implementing ETCS and TM systems, ATO provides in-cab digital decision support tools to give drivers the information they need at the right time to boost performance and safeguard safely.

ETCS can be configured to operate in one of the following application levels:

- **ETCS Level 1**: Movement authority is passed to the train via a switched balise or transmitter on the track, while a conventional signalling system continues to be used. Though cheap to convert the current system, only the interoperability and improved safety benefits are achieved.

- **ETCS Level 2**: Movement authority is passed by GSM-R radio network from a Radio Block Centre to the train. Conventional trackside detection systems are used with the interlocking signalling system. This is the level proposed across the UK network and provides capacity benefits with increased track sections to move into.

- **ETCS Level 3**: Builds on level 2, but uses critical data from the train rather than conventional trackside systems. This allows a system of moving “virtual blocks” around the trains, which will allow for calculation of a minimum safe braking distance behind them. This means that track capacity isn’t defined by track sections broken up by signalling, but by the maximum number of trains which can operate, subject to a safe braking distance between them. The UK will be aiming to reach this level in the long term.

**ETCS Level 3 technology** relies on the trains assuring their own integrity, guaranteeing they haven’t left a carriage behind on the track for others to hit. Not all trains have this capability, and in particular, freight trains are far less likely to. As such, Level 3 presents a technological challenge to tracks with a variety of traffic.

A solution presented by Arcadis in the Netherlands is ETCS Robust Level 3, where trackside detection equipment is used to assure a safe distance behind trains which cannot assure their own integrity (such as freight trains) and Level 3 is used for trains which can.

With gradual introduction of trains equipped with train integrity monitoring, track capacity could be increased without needing to modify trackside train detection equipment. Eventually legacy trackside equipment could be removed.

This thinking has already been put to the test by Arcadis, ProRail, Bombardier and Alstom in the Netherlands in a successful proof of concept. The principles of this solution, “Hybrid ETCS Level 3”, have been jointly approved by several European rail infrastructure managers, Unisig, and the majority of the ETCS industrial parties.

<table>
<thead>
<tr>
<th>Year</th>
<th>Description</th>
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<tr>
<td>2013</td>
<td>Testing began at ETCS National Integration Facility (test track on Hertford Loop)</td>
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<tr>
<td>2017</td>
<td>ETCS level 2 installed Western Paddington-Heathrow allowing Crossrail ETCS to run</td>
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<tr>
<td>2018</td>
<td>ETCS level 2 overlay Kings Cross-Wood Green area (signals removed 2020)</td>
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<tr>
<td>2018</td>
<td>ETCS level 2 with no signals Moorgate-Drayton Park</td>
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<tr>
<td>2019</td>
<td>ETCS level 2 Western Paddington-Bristol (signals removed by 2025)</td>
</tr>
<tr>
<td>2020</td>
<td>ETCS level 2 wit no signals on East Coast Main Line Kings Cross-Doncaster</td>
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ECONOMICS
Capacity benefits include:
• Up to 40% more capacity, delivered at 30% lower cost than normal line construction.
• Increased number of reliable train paths, enabling more people to travel and more goods to be transported.
• Improved performance as a result of reduced lost track space.
• Faster recovery from faults when they occur.
• 35% reduction in primary delay caused by signalling asset failures.
• Safer operations, with 80% fewer signals passed at danger (SPADs) and less trackside maintenance danger.

Flexibility benefits include:
• Agile timetabling to adapt supply to meet demand, including freight and passenger mix.
• Reduced journey times due to better connectivity.
• Better connected inter-modal freight nodes.
• Fewer line closures by exploiting bi-directional network capability.
• Scope for turn-up-and-go style travel similar to underground systems.
• Better train management during disruption.

Open data benefits include:
• Clear real time multi-modal journey planning information and ticketing for passengers.
• Helpful passenger information during disruption.
• Intelligent passenger guidance from one mode to another.
• Electronic ticketing with open interfaces for ticket/token validation.
• Greater scope for service differentiation.

Additional benefits to be considered include:
• Safety: A 50% reduction in trackside signal and control maintenance reduces risks to workers.
• Resilience: Removal of trackside equipment, which is vulnerable to damage by weather and vandalism.
• Environmental: Eliminating start/stop traffic reduces equivalent energy consumption up to 15%.

STAKEHOLDERS
Given the complexity of the Digital Railway programme and the many stakeholders involved, success will depend on co-operation.
A whole industry approach is needed, which includes:
• Investment by owners and operators in upgrading rolling stock, or retrofitting newer stock, as well as re-skilling the workforce to deliver more flexible working practices.
• Investment by the infrastructure operator in communications, command and control information, power infrastructure, and re-skilling operational and maintenance staff to work with digitally enabled processes and tools.
• Investment by government to change regulation and franchising frameworks to put enablers and incentives in place to accelerate change.
• Investment by the supply chain in technology solutions and in building the required skills base to deploy them.

Some of the principal stakeholders involved are:
• Network Rail are the infrastructure owners and are responsible for introducing Digital Railway across the national railways.
• Implementation will require integration of a broad range of suppliers to deliver the full system. This will include supplying the GMS-R backbone, the ETCS/TM technology as well as power supply, infrastructure civils and demolition works.
• Train operating companies and freight operating companies will be impacted by many of the planned changes. They will need to update rolling stock to ETCS-enabled trains, and implement other elements of the programme, such as digital ticketing.
• Passengers have increasing information and flexibility needs, which will be answered by modernising data collection. They will see the most capacity gains.
• Demand by freight users is growing, and the current system is not meeting customer needs. Improvements to timetabling, capacity and safety will benefit the industry, and provide an economic boost by facilitating commerce.
• Rail unions need to be taken into consideration to ensure minimum strike disruption.
As technology is brought onto the train and away from trackside, signalling risk and cost is transferred from Network Rail to the train and freight operators. Ensuring they benefit is essential in making the business case work, most likely through changes to the train operating companies service contracts to reflect the shift in risk patterns and incentivise updating the rolling stock.

With the process of “Network Change” in the UK, where all franchises need to agree to any infrastructure changes, implementation of ETCS may be held up until financial compensation is sorted out.

**PROCUREMENT & SUPPLY CHAIN**

Digital Railway has engaged the supply chain through an early contractor involvement workstream, ensuring the expertise of the global supply chain is taken into consideration when forming specifications and plans. This also gives suppliers early visibility of the pipeline, increasing confidence in funding and commitment to the programme.

Digital Railway’s Early Contractor Involvement Report demonstrates that a fundamental change to the way the industry works with the supply chain is required. The industry reform programme will focus the supply chain on delivering outcomes and whole life costs and performance.

Collaboration will allow suppliers to develop the right solutions together with Network Rail and tap into lessons learned from other countries. Conservative estimates suggest that cost savings could be as much as 10%, growing to 30% over time. In addition, disruption could be minimised by co-ordination across the supply chain, and risks could be identified and addressed earlier.

As such, Digital Railway will work with the Rail Supply Group to continue early contractor involvement, developing the initial findings of the benefits of Digital Railway and embedding these into the targeted set of business cases being developed. The findings will also inform work to develop the integrated industry plan. Early contractor involvement will also look to:

- Explore alternative funding mechanisms
- Develop a whole life commercial strategy which rewards and incentivises successful collaboration and delivery.
- Develop a Digital Railway industrial strategy focused on suppliers and skills development.
- Review restrictive legacy specifications.
- Exploit opportunities from intelligent infrastructure.
- Work with telecoms supply chain to ensure integration of requirements into digital train control specifications.

The overall aim is to develop a whole-life relationship with suppliers that takes them not just through cost but performance, reliability, availability, upgrades and obsolescence management.
A procurement strategy will be created, emphasising industry engagement, information sharing and collaboration. Commercial innovation will be required as well as enabled by the programme, making it an important driver for increased affordability, efficiency, performance and sustainable risk transfer. Supplier consensus has been reached that the NEC3 suite of contracts would support the collaborative arrangements required to enable multi-party delivery of schemes. Rather than developing a specification in-house and then putting contracts for digital technologies out to competitive tender, Network Rail aim to involve suppliers in writing specifications to ensure engagement and clarity from the start.

CONCLUSION

One of the main challenges the Digital Railway programme faces is simply one of momentum, and that will only come with the first deployment of works. With funding set aside, pilot schemes identified and an industry plan and commercial strategy coming together, Digital Railway must now push forward into implementation, and demonstrate the benefits to the UK, justifying the programme as well as giving confidence to the supply chain.

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