Digital Railway for Freight and National Passenger Operators

July 2019

Continuous Modular Strategic Planning

System Operator Planning a better network for you

Abbreviations & Definitions	
Acronym	Meaning
AFO	Adjacent Facility Owner
ATO	Automatic Train Operation
CDAS	Connected Driver Advisory System
CMSP	Continuous Modular Strategic Planning
CP	Control Period
DR	Digital Railway
ECML	East Coast Main Line
EMU	Electric Multiple Unit
ERTMS	European Rail Traffic Management System
ETCS	European Train Control System
FIC / FiC	First In Class
FNPO	Freight & National Passenger Operators – throughout this report this refers to the Freight and Train Operating Companies that are aligned with the Network Rail FNPO route
FNS	Freight Network Study
FOC	Freight Operating Company
FY	Financial Year
GB	Great Britain
HGV	Heavy Goods Vehicle
HS2	High Speed 2
LTDP	Long Term Deployment Plan
LTPP	Long Term Planning Process
NPR	Northern Powerhouse Rail
NR	Network Rail
ORR	Office of Rail & Road
RBC	Radio Block Control
RDG	Rail Delivery Group
RIDC	Rail Innovation & Development Centre
RSL	Rolling Stock Library
RSSB	Rail Safety & Standards Board

SEU	Signalling Equivalent Unit
SRFI	Strategic Rail Freight Interchange
STP	Short Term Planning
TfN	Transport for the North
TM	Traffic Management
TOC	Train Operating Company
TPR	Timetable Planning Rules
TRU	Transpennine Route Upgrade
VSTP	Very Short-Term Planning
WCML	West Coast Main Line
WTT	Working Timetable

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Part A: **Executive Summary**

Rail freight is a success story. Whether it is taking lorries off the roads and drastically reducing congestion or transporting goods that we consume every day, Britain relies on rail freight to provide a faster, greener, safer and more efficient way of transporting goods than roads. The rail freight industry secures over £1.7bn of economic benefits for Britain a year[1], benefits that are being felt right across the country. It is an indispensable part of the British economy, and an essential component in supporting economic growth and long-term sustainability of freight transport.

Freight Operators face the same capacity challenges as their passenger counterparts, exacerbated by the long distances typically travelled. There is an ongoing need for more capacity and better performance to accommodate growth in demand.

Digital Railway (DR) aims to transform the rail network for passengers and freight by deploying modern signalling and train control technology to increase capacity, reduce delays, enhance safety and drive down costs. Its strategy is to deploy digital signalling and train control systems to address specific capacity and performance pinch points on the network[2].

This piece of Continuous Modular Strategic Planning (CMSP) has examined how the benefits of Digital Railway implementation can be realised effectively for freight and national passenger operators given the complexity of their network requirements. It also recognises that the benefits of DR implementation may not be fully realised for non-FNPO operators if the needs of freight are not fully addressed. The study has been informed by and produced in partnership with Freight Operating Companies, Rolling Stock Companies, National Passenger Operators, Freight representative bodies and other subject matter experts.

The recommendations in this study have been developed by Network Rail in partnership with stakeholders to support continued development of rail freight and national passenger operators within the rail industry and contribute towards economic growth and environmental plans of the UK. The priority recommendations have been identified as:

- A requirement for the safety risks of transitioning between ETCS level 2 and conventional signalling areas to be assessed and the number of transitions that can be safely accommodated in a single journey identified.
- Industry, via RSSB, should support a project to identify the most appropriate braking curves for freight to allow additional capacity to be safely exploited. In tandem with this, technology solutions to enable the risk of human error in inputting lambda values to the ETCS system to be mitigated should be initiated.
- Business cases should be developed to secure funding for continuation of the programme of works to allow full fitment of freight locomotives, including synergies with other national programmes where appropriate.

[1] https://www.networkrail.co.uk/industry-commercial-partners/rail-freight/

[2] https://www.networkrail.co.uk/our-railway-upgrade-plan/digital-railway/

Part B: **Introduction**

B.01 Sector Background

Rail freight is a success story. Whether it is taking lorries off the roads and drastically reducing congestion or transporting goods that we consume every day, Britain relies on rail freight to provide a faster, greener, safer and more efficient way of transporting goods than roads. The rail freight industry secures over £1.7bn of economic benefits for Britain a year[3], benefits that are being felt right across the country. It is an indispensable part of the British economy, and an essential component in supporting economic growth and long-term sustainability of freight transport.

Rail freight has sustained growth in key sectors such as intermodal and construction, despite the loss of power station coal in 2015. In addition to this rail freight has found a way to become far more efficient than it ever was before; since 2003 the amount of freight moved on each train has increased by more than 75% while the number of freight trains has fallen by 46% over the same time period. This has resulted in a decrease in the number of freight paths on the rail network and increased the economic and externality benefits for each path used on the rail network.

£30 billion of goods are moved around Britain annually and the economic and environmental benefits of this are not to be underestimated[4]. The 2013 Freight Market Study[5] (currently being refreshed) highlights the forecast growth and demand for rail freight continues, where rail capacity is available. In 2016 the DfT published its Rail Freight Strategy[6] which highlights the importance of rail freight to the GB economy and how they are working with freight to ensure benefits from digital signalling are realised for freight.

The great success of rail freight has been driven by a number of factors including an increase in above rail competition, improved reliability and service quality and increasing pressures from road congestion and environmental concerns. There has been significant private sector investment from train operators and end customers as well as ports, terminal developers and the supply chain. There has also been significant investment from Governments and other funders who have supported network upgrades for increased capacity and capability for freight services.

National passenger operators, those who run services not predominantly geographically aligned with a Network Rail route, are recognised as CrossCountry, Caledonian Sleeper, charter operators and aspirant open access passenger operators. These train operators play a vital role in the movement of passengers around Britain and complement services run by other franchised operators, with a key target audience of leisure travellers but also being used for commuting, business and other travel purposes. In total there are circa. 1000 freight and national passenger services that run around Britain on a daily basis. Whilst the CrossCountry and Caledonian Sleeper services currently operate on a franchise, other operators purchase individual slots to run trains on the main network.

Freight and passenger operators face competition for capacity on the increasingly crowded network. Forecasted growth and demand means that operators must realise the opportunities that enhancement to the railway can bring to allow rail freight to grow and continue its promising trend of economic and environmental contribution to Britain, with national operators continuing to serve a vital market sector.

[3] https://www.networkrail.co.uk/industry-commercial-partners/rail-freight/

[4] https://www.networkrail.co.uk/the-positive-impact-of-rail-freight/

[5] https://cdn.networkrail.co.uk/wp-content/uploads/2016/11/Freight-Market-Study.pdf

[6] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/552492/rail-freight-strategy.pdf

Findings ways to drive capacity and performance improvements in the rail industry is an ongoing challenge and the Digital Railway presents an opportunity here if the proposed benefits can be realised. The implementation of Digital Railway can offer governments a more cost effective way of increasing capacity and other benefits than traditional infrastructure enhancements.

B.02 Continuous Modular Strategic Planning

Continuous Modular Strategic Planning (CMSP), an element of the Long-Term Planning Process (LTPP), is a flexible, customer driven long-term planning approach which allows for effective stakeholder engagement to produce industry recognised recommendations for funders to consider for enhancement, growth and the development of the rail network.

The aim of CMSP is for it to be customer focused and driven by the needs of passengers and freight users, with a specific focus on localised or stakeholder benefits. It is quicker to produce outputs than other strategic planning tools and is iterative, any strategic questions that are established at the outset are revisited and will evolve as stakeholders' priorities change and the study matures.

Key features of CMSP are;

- identification of the core organisations and stakeholders to be involved;
- collaboration amongst stakeholders directly involved in the study and a wider group who inform the work; and
- regular feedback of outputs.

B.03 Strategic questions

Identification, prioritisation and definition of strategic questions amongst stakeholders is a key step in the early stages of a CMSP study.

The strategic questions agreed by the working group, consisting of key stakeholders (see Appendix 1: Governance) were as follows.

- What benefits for FNPO's stakeholders can be realised in CP6 from existing programmes?
- What interventions or programme changes are required to deliver these?
- What benefits for FNPO's stakeholders could be realised in CP7 and beyond?
- What interventions or adaption of programmes would be required to realise these?
- How are the benefits of Digital Railway integration best demonstrated across industry and wider stakeholders?

B.04 Digital Railway as a concept

Digital Railway (DR) aims to transform the rail network for passengers and freight by deploying modern signalling and train control technology to increase capacity, reduce delays, enhance safety

and drive down costs. Its strategy is to deploy digital signalling and train control systems to address specific capacity and performance pinch points on the network[7].

There will be an overhaul of current signalling equipment and the introduction of new in-cab technology combined with new systems, ways of working and a modernisation of the way the rail network operates. DR technologies will help industry overcome some of its most significant challenges by:

- safely allowing more trains to run per hour by running trains closer together (if the Level 2 system is optimised or once Level 3 ETCS is implemented);
- allowing more frequent services, also more seats could also be implemented with longer trains;
- enabling increased capacity on the rail network in a more cost effective way than conventional infrastructure upgrades
- cutting delays by allowing trains to get moving more rapidly after disruption; and
- enabling vastly improved mobile and wi-fi connectivity, so that passengers can make the most of their travel time and communities close to the railway can connect more easily[8].

ETCS level 2 technology is proven here in Britain on London Underground (albeit on a simpler network and with a single type of rolling stock) and abroad with many countries' national rail networks using a variety of digital technologies. Challenges remain around the cost of implementation and operational hurdles, which will need to be overcome, particularly around retrofitting complex existing networks and proving Level 3 technology, but it is a case of when and not if for the GB network.

For the purpose of this report we have considered two types of digital technology – European Train Control System (ETCS) and Traffic Management (TM) systems. Other technologies included in the DR programme such as Connected Driver Advisory Systems (CDAS) and Automatic Train Operation (ATO), which can provide drivers with in-cab support and information were agreed to not be considered by the working group (see Appendix 1: Governance). It was agreed that the benefits of these to FNPO would be more limited than ETCS and TM and focus should be given to the technology that offers the most potential.

ETCS – European Train Control System

ETCS is the core signalling and train control component of European Rail Traffic Management System (ERTMS). ETCS continuously calculates a safe maximum speed for each train, with cab signalling for the driver and on-board systems that take control if the permissible speed is exceeded. For ETCS trackside equipment and train borne systems need to be standardized according to the different ETCS levels. ETCS Level 1 can be easily superimposed on the existing national signalling system and provides cab signalling. Movement authorities can be granted through fixed and switchable Eurobalises. They also send route data to the on-board unit. With the received data the maximum speed as well as the breaking curves are calculated at any time. ETCS Level 2 is a radio-based system which displays signalling and movement authorities in the cab. The train is continuously sending data to the Radio Block Centre (RBC) to report its exact position and direction. Eurobalises are used as passive positioning beacons. Trains refine their position with additional sensors such as accelerometers, odometers or radar. The most advanced level of ETCS technology is Level 3, this is a fully radio-based system without any trackside equipment. The Radio Block Centre (RBC) receives positioning of each train continuously and calculates smallest possible train distances at any time. Therefore, the track is no longer separated in fixed blocks but split into "moving

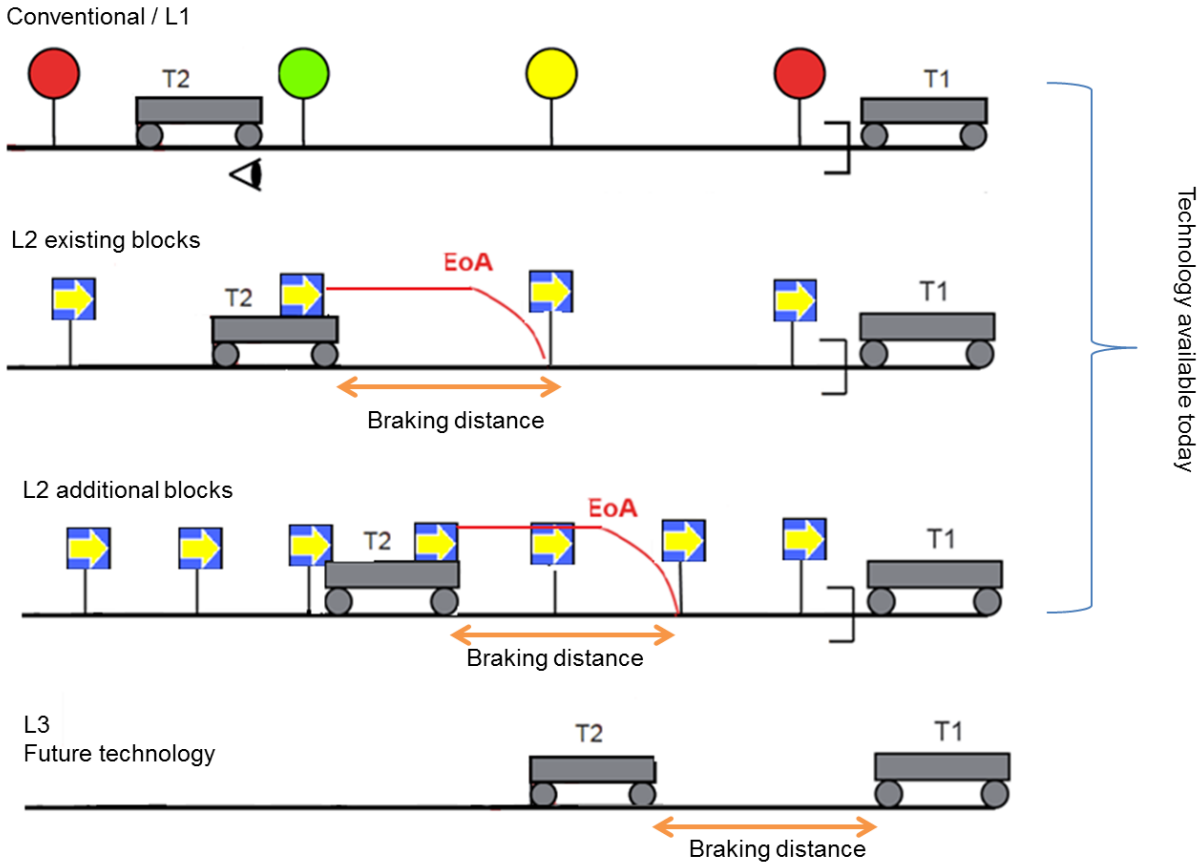
[7] https://www.networkrail.co.uk/our-railway-upgrade-plan/digital-railway/

[8] https://www.gov.uk/government/news/digital-rail-revolution-will-reduce-overcrowding-and-cut-delays

blocks". At the same time, it is vital that trains guarantee their integrity as there is no trackside equipment available to provide this information[9]. Whilst there is intention to roll out Level 3 technology, this is still in development and may be some time off for the GB network.

It is expected that the majority of the capacity benefits associated with the introduction of ETCS will be realised progressively from Level 2 with additional block sections through to Level 3 implementation.

Figure 1. ETCS levels. For the purpose of this diagram EoA is an abbreviation of 'End of Authority'.



Traffic Management

An Integrated TM system supports high levels of automation during normal working and around conflict resolution – It is used by various roles across route teams to a) validate and de-conflict the days plan prior to start of service, b) resolve conflicts and considerations as they occur, and c) plan/re-plan the train service during times of perturbation. Manipulation of the train service within TM, either via automation or manual manipulation by a user, results in the route setting sub-systems carrying out the intended actions. TM informs schedule manipulations by providing a forecast prior to any measures being applied in order that a user, or indeed the TM system itself, can understand the impact of each proposed solution, therefore allowing the optimum solution to be implemented[10]. TM allows a user, typically stationed in a control centre, to manage operational issues almost immediately and it can predict conflicts, providing resolution to problems and a tool to re-plan real time in the event of unforeseen circumstances on the network. This is a screen-based

[9] https://www.thalesgroup.com/en/european-train-control-system-etcs

[10] Digital Railway Traffic Management – Generic Principles & Functionality. Network Rail | Digital Railway March 2018

computer system and users need to be well trained and aware of the operational challenges the railway can present.

Figure 2. Technology Benefits[11]

Benefits

	Enhanced safety for passengers and workforce	Increased capacity to meet demand	Better performance for passenger and freight customer journeys	Enabling faster journey times	Less disruption from renewals, maintenance and upgrade	Better asset sustainability (lower whole life cost)	Enabling data connectivity for passenger and freight customers, as well as assets
Safe separation of trains - ETCS	✓	✓	✓	✓	✓	✓	
Traffic Management	✓		✓		✓		✓

B.05 The importance of Digital Railway to Freight & National Passenger Operators

Freight and National Passenger Operators face the same capacity and performance challenges as other operators. Industry's challenge of running more trains, more frequently and with greater reliability is being felt by all.

Freight services and cross boundary, long distance passenger services such as those operated by CrossCountry and Caledonian Sleeper are some of the longest in duration of any that run on the GB network. Most passenger train operating companies are simply not accustomed to running for the length of time that, for example, a freight train from Liverpool to Felixstowe does or similarly the Anglo-Scottish sleeper.

The length of running time by FNPO service providers offers opportunity and the potential benefits of DR, namely reduced journey times, operational resilience and incident management create a sense of optimism. The capacity released by new technologies, and an ability to run trains closer together and more frequently should be a benefit that can be realised by Freight & National Passenger Operators as well as more route specific operators.

If DR technologies create capacity to run additional freight services, the benefit is a freight modal shift from road to rail measured by the DfT's Marginal External Costs for HGV's. These benefits are, in effect, the business case for support of freight operator fleet fitment. Currently economic benefits (such as user benefits) and wider economic benefits (such as benefits to conurbations of efficient delivery of goods, and the ability of businesses to connect to market) are not included within the

[11] https://digitalrailway.co.uk/wp-content/uploads/2018/11/Digital-Railway-Programme-Strategic-Plan.pdf

formal business case but offer additional context. The strategic benefits of modal shift of freight to rail are well understood, safety, environment, decongesting the roads

However, there are additional implications of digital technology implementation for FNPO that need to be taken into account. A train service that travels over areas of ETCS enabled network, back into conventional signalling sections to perhaps repeat this occurrence time and again during the length of the journey will bring with it challenges around planning; driver training and route knowledge; locomotive capability and potential confusion and human error. There are safety issues requiring absolute clarity here. This is an industry challenge and a question being asked by train operating companies (TOCs) operating services on all parts of the network.

DR creates opportunities for the FNPO customer and stakeholder base, and in particular DR should support a more cost effective way of Network Rail increasing capacity on the rail network than other traditional interventions such as building new tracks. However, as this report highlights there will be challenges along the way and the input, recommendations and concerns of these operators must be considered when developing enhancement and roll out plans that will affect their business interests.

Part C: **Study approach**

This piece of CMSP has been endorsed by industry partners and led by the System Operator FNPO strategic planning team. The remit for the work was produced in collaboration with working group members and signed off by member organisations and the relevant governing boards. The design and development of the strategic questions and subsequently the workstreams/topics for further investigation has been through working group discussions and stakeholder prioritisation at an early stage of the study.

Eight workstream topics were established and approved for relevant research to be carried out and recommendations to be produced, as agreed by working group members. The workstreams were designed to cover a broad spectrum of areas that stakeholders identified as requiring further clarity when considering the implementation of digital technologies on the rail network.

This work sets out options for funders and industry parties, of ways of working together, and key issues surrounding the implementation of DR technologies that need to be considered and resolved collaboratively to ensure that the benefits of DR technologies are realised for FNPO and all other operators & their customers.

This work will complement other studies being done within Network Rail by Digital Railway and route businesses.

Part D: **Findings and recommendations**

This section of the report details the findings and recommendations from each of the individual workstreams that the study has been built on. These workstreams focussed on some of the most relevant aspects of the Digital Railway programme for FNPO, as identified and agreed by the working group. This section considers the roll out plan for digital upgrade to the network, identifying and drawing conclusions upon how well this strategic approach is set up to benefit this sector of industry and what additional or changed plans might be needed to ensure that FNPO is in a strong position to benefit from the modernisation of signalling technology through ETCS and management of operational circumstances through TM.

Six of the eight workstreams have been considered and will be discussed in this section of the report under a heading of either ETCS or Traffic Management, the final two further workstreams need to be considered within the context of both types of technology.

- Freight corridors – sets context around the key geographical areas of the network and relevant markets for the freight industry to allow for recommendations through implementation of Digital Railway technologies to be explained further in subsequent sections of the report.
- Digital Technology: ETCS strategy – details the principles of ETCS technology that this report will consider, the roll out plan for this technology and how train services might interact with these technologies upon implementation.
- Freight in-cab fitment – provides an overview of the current freight in-cab fitment programme, acting as enabler for DR (ETCS) across many areas of the network, drawing conclusions and recommendations on current funding arrangements and outlining requirements to allow the programme to move forward.
- Freight braking curves – provides a better understanding of modern braking curves that can optimise capacity realisation from ETCS implementation for all users.
- Digital technology: TM systems – considers the key elements of TM technology and the relevance to freight, commenting upon opportunities within the sector to realise benefits of using the tool to manage conflict and planning.
- TM and the timetable planning process – this raises awareness of the opportunities for Digital Railway through TM, to inform the timetable planning process, recommending further work to draw out benefits and create a model of how this will work operationally.
- Freight facilities – provides an overview of the key facilities that freight services use to provide context of the considerations industry needs to make when implementing digital technologies to realise benefits for freight.
- National passenger operators – provides background and context to the national passenger operators who sit within FNPO to outline some of the key concerns and opportunities from digital technologies (both ETCS and Traffic Management).

European Train Control System

D.01 Freight corridors and ETCS Long Term Deployment Plan (LTDP)

These two workstreams examined the rail freight market with a focus on the strategic freight network corridors, the types of growth and the routes that certain commodities of freight will use and how this then aligns with the DR ETCS LTPD.

Recommendations in this section look at how the ETCS LTDP aligns with the established freight corridors and where benefits may accrue most quickly if changes to the plan are made.

Appendix 2 contains details of the 11 key freight corridors and the timeframes for when ETCS Level 2 is planned according to the DR LTDP.

In April 2017, as part of the LTPP Network Rail produced the Freight Network Study (FNS). This considered how the rail network could accommodate freight growth over the next 30 years and defined clear priorities for delivery. It provided an overview of the current plans for the enhancement of the rail freight network; proposed a range of future capacity options and recommendations; considered short and long-term capability options and provided a range of possible options for investment for the next 30 years. As the DR programme involves a body of enhancements over a similar timescale, later sections of this report will look to outline how the priorities for the rail freight market map against the current plans for ETCS Level 2 (and TM) roll out looking to identify where the benefits for freight can accrue the fastest.

In the development of ETCS Level 2, there is an opportunity to align some of the programme with existing priorities that offer enhancements for freight customers based on capacity, gauge and capability.

The introduction of HS2 services will have an impact on freight with potential new capacity on the West Coast Main Line south of Crewe following the completion of Phase 1 and 2a and potential conflicts north of Crewe where classic compatible HS2 services to Liverpool and Scotland will share the same infrastructure as freight trains. The FNS identified a number of priorities along the West Coast Main Line corridor north of Preston to realise benefits for freight in anticipation of increased capacity constraints following the introduction of HS2.

The FNS recommended that further infrastructure interventions to be aligned with HS2 to enable development of a long-term strategy for the corridor. Both Transport for the North (TfN) and Transport Scotland should also be aligned in the development of a joint strategy particularly as ETCS enhancements are timetabled to be quite early in the ETCS rollout on the West Coast Main Line route north of Preston.

With the completion of HS2 Phase 2B to central Manchester and Leeds and the development of Northern Powerhouse Rail (NPR), further opportunities may develop during the life cycle of the ETCS deployment for other key enhancements along corridors that may offer significant benefits for freight customers. Some enhancements to the classic network are already planned that feed into this such as electrification of the Midland Main Line from Chesterfield into Sheffield.

This report outlines where freight can benefit most from ETCS deployment in line with the current market for freight and the timetable of priorities along the eleven key freight corridors highlighted in the FNS. It will also be important to understand the priority for the future Network Rail Regions so that synergies can be sought in the delivery of infrastructure upgrades. There is a need to ensure any priorities identified by FNPO or in conjunction with Regions, can be funded.

Clearly where assets are relatively close to life expiry along the key freight corridors, there is an opportunity early in the deployment cycle to examine the priorities along that corridor so that analysis can be made of the viability of further infrastructure enhancements along with any ETCS upgrade.

If ETCS implementation is to be aligned with the renewals work bank and driven by individual business cases, this will lead to a piecemeal approach which in turn will see little or no benefits for freight and national passenger operators being realised until much of the network has seen deployment.

Following the release of the ETCS LTDP, this report identifies the West Coast Main Line corridor north of Crewe and the Felixstowe to West Midlands corridor as those offering the most potential benefits for freight as there are many early deployments of ETCS during CP7 and 8 and both corridors see large amount of freight movements per day.

The deployment plans and the plans to fit the Freight and National Passenger Operator locomotive fleet need to be aligned. For the freight fleet, the nationwide basis, the need to react to customer demand and the competitive nature of the sector mean that the majority of the fleet would need to be fitted at an early stage to support the use of ETCS on the below key route sections.

Along the West Coast Main Line in particular, the use of HS2 classic compatible trains due to begin operation during the second half of CP7 may further a business case for enhancements that also benefit freight. Between Crewe and Preston there are opportunities for ETCS deployment and enhancements during CP7 to be co-ordinated together. ETCS deployment north of Preston to the border is planned for CP8 so the case to develop other schemes in tandem could be taken forward.

Along the Midland Main Line South, there are plans for early ETCS deployment and further electrification schemes from Kettering to Market Harborough present an opportunity for further freight benefits, particularly for aggregate trains from the East Midlands going south.

The appendices of this report offers maps and a table of SFN schemes from the 2017 FNS with associated ETCS deployment for each of the freight corridors. With this information the SFN steering group can determine if established SFN priorities should be changed and begin to plan a timetable for them.

Corridor 1. West Coast Main Line (WCML), including impact of HS2

The corridor north of Crewe is a key priority for consideration. ETCS deployment is identified as aligning with the renewals work bank during CP7 and CP8. ETCS deployment of Carstairs Junction aligns with renewals in CP10. If this were accelerated, it could align with the SFN/Scotland route priority for remodelling the junction as it also offers journey time benefit for HS2/Transpennine services as well as freight.

Recommendations

Scotland Region should consider the acceleration of implementation of ETCS at Carstairs Junction to align with ETCS implementation on the remaining WCML north of Crewe in order to provide continuity of signalling and potential capacity and journey time improvements associated with remodelling Carstairs Junction.

The SFN Steering Group should consider the prioritisation of enhancements benefiting freight north of Crewe taking into account the potential alignment with proposed ETCS timescales.

Corridor 2. East Midlands & Yorkshire

The majority of ETCS deployment along this corridor occurs during CP8 and CP9. Many of the identified freight priorities along this corridor align with this timetable. There is potential to align further capability benefits around electrification on some of the Yorkshire lines with ETCS deployment beyond CP8. For routes to the Humber, enhancements to the route as part of NPR can align with ETCS deployment and freight aspirations for the route. However, there is currently no timetable for any enhancements on this corridor.

Corridor 3. Felixstowe to West Midlands and the North

This is a key corridor where proposed infrastructure upgrades can offer early benefits for freight customers. ETCS deployment is planned from Syston to Peterborough during CP7. There may be a potential for a business case to bring deployment in the Ely area forward from CP9 in line with priority enhancements in the area.

Recommendation

The SFN Steering Group should work with the Digital Railway team and Eastern Region to explore whether there is a strengthened business case and efficiency from aligning ETCS deployment with the in-development freight growth proposals.

Corridor 4. Southampton to the West Midlands and the West Coast Main Line

Much of the ETCS deployment in this corridor is very late in the deployment cycle with the earliest likely to be the diversionary route from Southampton to Basingstoke via Andover. The use of East West rail from Oxford to Bletchley to access the West Coast Main Line and TM interventions (such as around the planned Eastleigh Nodal Yard) or with grade separation around Basingstoke may offer the most benefit to freight customers in the shorter/medium term.

Recommendation

As Eastleigh Nodal Yard is developed, Southern Region should work with FNPO to apply TM consistent with the plan for the remainder of the route.

Corridor 5. Channel Tunnel freight

There are opportunities for early ETCS intervention along the Maidstone and Tonbridge routes via CP7/8 to align with existing priorities in the Redhill area and gauge enhancements along the wider corridor to Wembley.

Corridor 6. Cross London freight flows including Essex Thameside

With much of the cross-London freight corridor planned for ETCS deployment during CP8, an opportunity exists to address this within the London Freight Strategy CMSP planned for early CP6 to identify in more detail a timetable for how priorities can be aligned with ETCS deployment. Some previously identified schemes such as 4 tph freight / 6tph passenger services on the Gospel Oak to Barking line can be examined as strategic questions.

Corridor 7. South West & Wales to the Midlands

Early ETCS deployment is planned along the Camp Hill Lines in Birmingham and down to Barnt Green during CP7. An opportunity exists to align identified SFN priorities such as grade separation around Barnt Green and Kings Norton particularly as local stakeholders wish to use the route for passenger services.

Corridor 8. Northern Ports & Transpennine

Much ETCS deployment along this corridor is quite late in the cycle. Earlier benefits for freight customers may arrive with planned TM updates along the corridor.

Corridor 9. Midland Main Line

There is potential along this corridor for freight benefits as ETCS deployment south of Bedford falls quite early in the cycle. In terms of the wider route, ETCS deployment falls much later between Bedford and Kettering North. There may be value in examining if deployment can be brought forward here, particularly if benefits from four tracking or speed improvements can add to a business case. There may also be a case for enhancements around Leicester to be brought forward from CP9 particularly as Corridor 3 will also use this alignment.

Recommendation

The SFN Steering Group should work with the Digital Railway team and Eastern Region to explore whether there is a strengthened business case and efficiency from aligning ETCS deployment with other enhancement schemes along this line of route.

Corridor 10. Great Western Main Line

Deployment is quite late in the cycle here although there are possibilities to align deployment with W10/W12 gauge enhancements or electrification infill to Portbury or Avonmouth in the longer term.

Corridor 11. Anglo-Scottish & Northern regional traffic

The western part of this corridor is covered by Corridor 1. Along the eastern corridor, ETCS interventions are planned along the majority of the route for CP8/9. Many of the strategic priorities along the route north of Newcastle are planned for CP6/7. There may be a business case for earlier enhancement of CP9 deployment south of Newcastle if HS2 Phase 2B and NPR services are operational which could add further journey time benefits for freight customers.

D.02 Digital Technology – ETCS Strategy

Digital Railway have prepared a train control deployment plan from CP7 onwards. The ETCS LTDP is a renewals-based plan with interventions timed relevant to the external signalling equipment expiry. As such it is, technology independent.

The plan concludes that:

- the current timetable for conventional signalling renewals is neither deliverable or affordable;
- the DR LTDP addresses asset sustainability;
- at current costs, funding in excess of CP6 levels is required in CP7-9;
- European benchmarking indicates cost reductions would make it possible to deliver the plan at close to CP6 budget levels;
- ETCS fitment for all trains is deliverable in the timeframes given by the infrastructure renewal plan;
- train fitment must start in 2020 (CP6) at an estimated cost of at £861m. £228m has already been allocated as part of CP6 funding. The remainder is currently unfunded; and

- ETCS renewals are faster than conventional trackside infrastructure. As ETCS delivers safety and performance benefits over conventional systems, it represents better value for money.

For the purposes of costing the plan only the intervention type has been assumed at present as ETCS level 2 “signals away” this is because this technology is at a more advanced stage, and comparable pricing is available from suppliers to use as a basis for the unit rate. It is expected that the most suitable technology will be used for any intervention be that ETCS level 3 as soon as it becomes available, or ETCS level 3 hybrid approach.

The plan outlines specific ETCS deployment (to Level 2) areas within each Network Rail route and an SEU (Signalling Equivalent Units – a unit equalling interlockings, points controls, signals and level crossings within a defined route area) within each ETCS area. Each deployment area will have varying numbers of SEUs. It also provides the financial year work is planned in line with the end of life cycle for the infrastructure. The SEU represents a generic base that any early cost estimates for an enhancement can be calculated from.

In relation to all train operators (TOCs & FOCs), the challenge operationally is that ETCS Level 2 deployment areas only represent a small line section of route relative to the network. Network coverage along a route would have different deployments so the timetable for roll outs as they stand would ensure a very patchy wider scale roll out across the system. This would ensure the benefits that may accrue for freight from ETCS including improved journey time and greater options for capacity will be limited until such time as a whole line of route along a key corridor is complete.

As this is part of a long-term enhancement programme, deployments in whatever form are likely to be incremental. In operational terms, during the deployment, there will be areas of the network that are ETCS enabled and areas that are not. Freight on rail is network wide and travels across route boundaries by its nature so the possibility of one or multiple transitions between ETCS and legacy signalling is certain. Understanding the impacts of this are key.

Driver training is accounted for in the LTDP, and the assumptions that make up driver training have also been detailed. It should be noted that once drivers have been trained for ETCS they will need to be using this knowledge to avoid the training becoming outdated. With the current patchy deployment plan the probability of this increases. It is assumed that there are three drivers per passenger unit upgraded to ETCS Fitted (from ready and retro-fit) that require training. Further assumptions are that driver training costs will be at an average run rate of £20M per year. For planning purposes as part of each scheme, drivers will require one day’s route briefing/refresh when conventional signalling is removed.

The ETCS LTDP roll out will lead to multiple transitions for any unit travelling the network. More recent research from the RSSB has indicated that transitions are not expected to create the increased workload originally feared for drivers, provided the fringes are well designed. The plan at this stage has not reached a sufficient level of development to show all the fringes and their design requirements, and it is acknowledged that this will need to be carefully managed. It is also noted that relevant Rail Industry Standards are currently being reviewed under RSSB workstream 17-010 (CCC System Transitions), so any assumptions made around transitions and drivability will be re-assessed in light of that.

Recommendation(s)

Whilst transitions are not expected to create increased workload the following questions should be assessed and answered by the Group Digital Railway team and Technical Authority;

What are the safety risks of transitioning between ETCS level 2 and conventional signalling areas?

How many transitions in a single journey are deemed acceptable and safe?

Digital Railway worked closely with Network Rail's routes during the development of the long-term plan. There remains the possibility of a change control process as part of this plan which can propose changes in the timetable of deployment. This process has yet to be designed and will be outlined by Digital Railway in due course.

D.03 Freight in-cab fitment

The freight locomotive fleet can operate anywhere in Great Britain and therefore the fitment of ETCS equipment to the fleet is a key enabler for rollout of ETCS infrastructure with no lineside signals across the network.

The freight programme overall scope is to design, install, test and approve the ETCS system on the current GB fleet of 745 vehicles (19 existing classes of freight locomotives) and support the associated business change to FOC staff to operate and maintain the system. There is provision in the programme to vary the scope to include any likely changes to the GB freight fleet. The programme delivers a permanent shift of the signalling system boundary to the FOCs to enable future ETCS infrastructure deployments across the network.

The work to develop the freight fitment programme has been done by drawing on experience from related UK schemes and from international examples. Of note are the delays to implementation in Denmark. As a result of rolling stock fitment, a critical path activity, not being completed in time, delays have shaped the programme's deployment and priorities. In addition, stakeholder engagement has been a key activity with the freight operators and the ASLEF union being engaged as a core part of the programme.

A contract has been let with Siemens Rail Automation Holdings Ltd (Siemens) to deliver this programme. This programme starts with fitment of ETCS equipment to one vehicle of each of the 19 classes of freight locomotive. This is known as the First in Class (FiC) fitment. Class 66 locomotives operating in Great Britain have two distinct cab layouts across multiple variants; there are therefore two Class 66 fitments in this First in Class programme resulting in 20 First in Class vehicles in total.

At the end of the FiC phase, there is a proven and tested design that can be deployed on the remaining freight locomotives for each class. The prioritisation for this fitment will depend upon the routes being ETCS enabled as well as the locomotives that routinely use those routes.

The ETCS Freight Programme as it stands today is currently part of the c.£84m Cab Fitment Programme alongside 4 passenger First in Class (FiC) projects and the upgrade of test facilities at the Melton Rail Innovation and Development Centre (RIDC).

While pressures external to the ETCS freight funding programme have necessitated changes to funding, the underlying reasons for ETCS freight funding being required have not gone away; the case is still compelling and becomes more so the more routes that are equipped with ETCS infrastructure.

The mechanism to achieve full funding for the Freight ETCS Programme is yet to be determined. The DfT have indicated that they wish to consider each ETCS deployment as an incremental enhancement with an associated business case and ultimately final investment decision, it is assumed Transport Scotland will take a decision on its approach when a relevant scheme necessitates. It is assumed that the full CP6 investment decision on the Freight ETCS Programme will be made as part of a CP6 deployment scheme. The schemes in development are the Transpennine Route Upgrade (TRU) and the East Coast Digital Programme which are likely to reach a final investment decision by 2020. Both deployment projects are working on the assumption that the first date that ETCS Level 2 can be commissioned without legacy lineside signalling is December 2024.

The Freight Programme Outline Business Case (OBC) considers the potential funding options for the Freight ETCS Programme to maintain the momentum and efficiency of the current contractual arrangements, which are on the critical path to enable the benefits from deploying ETCS Level 2 operation without lineside signalling progressively from December 2024. At the same time, it seeks to mitigate the risk of stranded investments in Freight ETCS fitment, when the infrastructure required to derive benefits from this investment has not yet been committed to.

The remainder of the committed funding is proposed to take the following sequence of decisions.

- The Freight Programme OBC submitted in November 2018 for interim funding for the remaining FiC up to FY22 requiring £49.985m has now been approved.
- Further funding is required for fleet fitment and its preparatory works. Based on the current contract structure with Siemens this is needed by the programme before 1st April 2021. Further funding will be sought, aligned to, and perhaps part of, the East Coast Digital Programme or the Transpennine Route Upgrade final investment decision planned for 2020 for the balance of the CP6 works. This is currently forecast as £270m. It is worth noting that this cost may vary and is an estimate at this stage.
- Control Period 7 funding, of circa £250m, to be agreed as part of the Periodic Review.

It should be noted that the initial cost for retro fitment of the ETCS in-cab equipment is covered by the above, business as usual upkeep and maintenance of the equipment then becomes the liability of the FOC.

Scope of the Work

The contract and the unit rate cost of fitment per vehicle as well as the agreement with the FOCs are predicated on the full volume of the entire freight fleet of 745 vehicles being fitted. A stop-start approach or a smaller volume of trains will result in a higher unit cost.

The extent of the current scope of works up to March 2020, for the Freight ETCS Programme comprises of:

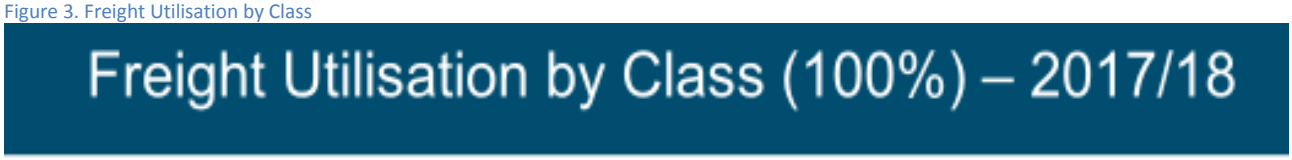
- three complete FiC vehicles, Classes 66 (first variant), 67 and 92;
- completed designs for Classes 60, 68, 70, 88 and 325; and
- provide a further design for the Class 66 which has many variants across the 387 vehicles currently in scope.

The work planned to take place between April 2020 and March 2022 is for Siemens to:

- complete the six designs for Classes 60, 68, 70, 88 and 325 to tested and approved vehicles and the second variant of the Class 66;
- provide a further eleven completed and approved FiC vehicles for classes 20, 73, 86, 90, DBSO, 82, 37, 47, 57, 59 and 56; and
- contingency funding for the above works, plus funding to allow managed change in scope in line with the existing contract with Siemens, including changes to the UK freight fleet consist.

The below shows the priority list for the fitment of Locos with ETCS equipment.

Figure 3. Freight Utilisation by Class



Class	Crewe	ECML S	EW	TRU	All	Priority	Comment
66	361	377	149	304	393	1	GO FiC and GO design for a class 66 variant which is priority 5
37	36	29	5	13	37	13	
68	33	5		8	33	7	GO design
90	24	8			31	11	
70	28	29	5	4	30	6	GO design
67	23	18		7	23	2	GO FiC
60	12	8		13	17	9	GO design
86	17	1			17	10	
325	15				15	8	GO design (quantities tbc)
57	14	6		6	14	17	
56	8	6	3	6	11	16	
92	10	1			10	3	GO FiC
88	10	1			10	4	GO design
47	6	6		1	9	18	
59	7	2	1	1	8	12	
73	3	2		5	5	14	
31		4		1	5	21	Not contracted, option only
20	1	3			4	15	
33	1	1			2	22	Not contracted, option only
50	2	1			2	99	Not contracted
46		1			1	99	Not contracted
87	1				1	99	Not contracted
89				1	1	99	Not contracted
DBSO						19	Quantities tbc
82						20	Quantities tbc
	612	509	163	370	679		

To support the scope of work the FOCs are required to provide:

- provision of candidate locos/EMUs for First in Class fitment;
- support and approval (including driver representative engagement) of the FiC designs;
- initial driver and maintainer briefing and training for operation of the FiC locos; and
- preparation for the next phase (training plans, vehicle release plans, handover procedures etc).

Additional to the FiC works described above, further activities beyond March 2022 and into CP7 include:

- preparatory works for the onboard supplier including procurement and preparation of materials, labour and work sites;
- preparatory works for the FOCs such that the vehicle can be operated and maintained with spares, test equipment, processes and procedures, training courses, planning staff release etc;
- fleet deployment of the balance of 725 vehicles which is planned to start in 2022 and continue to 2028 and will be prioritised for the fitment necessary to support committed infrastructure programmes;
- staff training including circa 2,500 drivers; and
- in service and ongoing support.

To have a complete ETCS enabled fleet that enjoys the benefits of digitally enabled infrastructure it is essential that the fleet fitment programme progresses so that operators can have continuity of business once the first infrastructure is fitted with ETCS. It is recommended that the programme continues and seeks the next tranche of funding for works post 2022 and for the rest of the control period. Quantification of benefits can only be carried out once other recommendations from this report are completed. If funding is not made available and the programme allowed to either stall or stop completely, not only will there have been significant investment that does not realise benefits in full, rail freight stands at risk of being left behind on the modernisation curve that industry is adopting. To recognise the importance of rail freight fully the sector requires an ability to continue influencing economic growth and decarbonisation, funding must match the ambition of this part of industry.

The key recommendation drawn from this workstream is for continuation of the fleet fitment programme to enable freight to operate on and reap benefits from a fully digitalised network. With funding currently only secured up until 2022 there is a significant gap that exists beyond this date and funding would be required to support work for the remainder of Control Period 7 and beyond. Two things must happen for the continuation of this programme. Value for money is key and significant costs are involved so various funding streams should be investigated to drive forward the work, realising that the current uncommitted sum is significant and will not be funded from within the FOC sector.

Recommendation(s)

Funding should be sourced for continuation of this programme of works to allow full fitment of freight locomotives. FNPO, Group Digital Railway and the DfT should continue to work together to identify funding requirements and a timeframe for completion of the work.

The freight in cab fitment programme should investigate how it could align with the decarbonisation challenges the rail industry is facing. There may be some overlap in new freight locos being required to meet the decarbonisation challenge which could be specified with ETCS equipment as part of a new build order.

D.04 Freight braking curves

The introduction of ETCS to freight vehicles requires the system to have a ‘model’ of the train braking system. The ‘model’ represents the braking curve(s) of the train from a given speed under a specified service brake level or emergency brake. This allows the system, when combined with infrastructure data, to determine a safe speed profile relative to a point whereby the train must have reduced speed or stopped. The brake ‘model’ must provide confidence that should the ETCS intervene it will slow or stop the train at or before the intended location.

The braking characteristics used to inform the current timetable are seen as conservative compared to the braking characterics of more advanced freight locos. When the brake model is too conservative this can have an impact on performance which has been observed on several occasions, one example being Auckland in New Zealand[12]. There is concern that importing an overly conservative braking curve into an ETCS system will lead to a reduction in the benefits that implementing ETCS could realise.

[12] https://www.nzherald.co.nz/nz/news/article.cfm?c_id=1&objectid=11249432

The variable formation nature of freight trains leads itself to a lambda (λ) braking model. This allows a single number, the brake weight percentage, to be entered into ETCS to represent the braking characteristics of the train in a given condition on a given day. A number of factors contribute to the brake weight percentage which include:

- the braking characteristic of each vehicle;
- the load of each vehicle;
- the quantity and type of vehicles making up the consist; and
- faults or isolated brakes within the consist.

There are challenges with determining the brake weight percentage, some examples include:

- the braking characteristics of vehicles are not always reliably documented and the Rolling Stock Library (RSL) is known to contain errors;[13]
- there is currently no practical means of determining the single number for the train consist from the various factors;[14] and
- there are concerns over the current proposed system of manual entry of that number by the driver allows human error[15].

A further key challenge is what level of protection ETCS provides in poor adhesion conditions. Depending on the approach adopted this could lead to a very conservative braking curve that would likely have a material impact on performance and capacity, limiting ETCS ability to improve performance and capacity.

A work stream is underway, led by the DR Programme System Requirements and Integration (SR&I) team to address some of the challenges faced deploying ETCS when considering the braking of freight vehicles. Clearly there will be safety, performance and capacity decisions to be made, with safety remaining the number one priority, which is within the remit of the workstream to consider. The current approach is to determine if a fixed lambda value could safely represent a broad range of trains, if not all, without a significant performance impact. This has the advantage that many, if not all of the challenges, are removed as there is no need to have vehicle data, derive the brake weight percentage and the challenges of entering a fixed number are much reduced if not removed.

The work stream consists of three interrelated elements:

- safety assessment;
- performance impact assessment; and
- drivability assessment.

Each of these elements will be considered and a report balancing each of the findings written to draw a conclusion and recommendations for how to proceed. The report is currently expected in March 2020. Whilst the focus is on a fixed lambda value, or at least a limited number of lambda values, should that be deemed not to be the preferred solution then the report will make recommendations for how the brake weight percentage may be derived safely and practically in day to day operations.

The conclusion of this work is vital in being able to understand what benefits there are to freight in relation to safety, performance and capacity. There is an inherent risk that the outputs of this work

[13] https://www.sparkrail.org/Lists/Records/DispForm.aspx?ID=8664

[14] Network Rail National ETCS Freight Programme – Train Data Entry Working Group Initial Report November 2015

[15] RSSB – ERTMS Start of Mission – Risk assessment of data entry errors – 2014

could reduce the existing capacity on the network if a fixed lambda is derived which is more conservative than today.

Given that extensive work is ongoing, in which the freight operating companies are engaged, the recommendation of this report at this time is for the workstream to take its course and, in further industry work on this subject, re-visit the discussiom on braking curves around April 2020.

Taking further any of the work identified in this workstream, further options exist for industry, including NR to collaborate with the RSSB to understand where Digital Railway technology can offer capacity benefits from developing a range of braking curves. A future piece of work can identify the right range and work out how these ranges are input to the system interface.

There is potential further alignment and operational benefits for freight in any future study from the RSSB around a future revision to the standard.

Recommendation(s)

The DR SR&I workstream needs to continue to engage and work with FOCs to deliver mutually acceptable ways forward.

Industry, via RSSB should support a project looking at the most appropiate braking curves to use for freight.

The Freight Stakeholder Group via the operator sub group, will continue to manage engagement with the DR team on braking curves and data entry.

Traffic Management

D.05 Digital technology: TM systems

TM offers the capability to provide automated control across the network. Depending on the level of integration and automation, it can automatically log, track and set train movements and identify and solve conflicts and considerations.

A conflict is defined as a competition for the same resource, these could include;

- insufficient headway between two trains along the same stretch of route;
- junctions where two trains would be required to use the same stretch of route;
- flat junctions where two trains travelling in opposite directions would cross paths; and
- platform arrival, dwell and departure.

A consideration is defined as a potential risk to efficient running of services these could include;

- turnaround time caused by delays;
- infrastructure restrictions and constraints e.g. trains routed from fast to slow lines;
- a train is diverted from its original route; and
- lack of available stock or traincrew.

TM has the capability to regulate train sequences, loop slower trains to be passed by faster services, divert trains onto other tracks/platforms, offer bi-directional working and add/increase dwell times. It can also offer resolutions on routes in advance of where a conflict has been detected by analysis of the infrastructure layout and available route; a forecasted outcome of an option or options to remove the conflict and identify or apply the most optimal of those options.

It can support re-planning of a train service in the event of major infrastructure failure, offer the functionality to create and validate new train schedules and the capability to apply speed restrictions to both the infrastructure and an individual train.

Freight services travelling across the country will generally share track with passenger services at all or some stages of their journey. Along the major flows of rail freight identified in this report, some of the routes will involve navigating pinch points on the network on routes within busy conurbations or main lines with high volumes of passenger services (often travelling at a higher average speed).

Several key interventions currently exist on the network aimed at reducing these conflicts. Various strategic passing loops have been designed for a freight train to be held until passed by a passenger service. Other services may require long waiting times at spurs and passing loops may have speed restrictions – all of these have a negative effect on end to end journey time for a freight train, driving up associated operating costs.

Freight utilises key routes such as the North London Line, Great Eastern Main Line and lines through Platforms 13 and 14 at Manchester Piccadilly from Trafford Park which have high volumes of peak and off-peak passenger services. The demand for capacity in these areas and conflicts which can arise can lead to a slower than average line speed for freight services and the impact can be felt by passenger services too, along what are major routes vital for the movement of both goods and passengers (there is potential for TM systems to manage these conflicts and create solutions for the benefit of both freight and passenger operators).

During CP6, a number of TM solutions will be in early development. For those that would relate most specifically to freight, feasibility studies or Strategic Outline Business Cases (SOBCs) are being developed for integrated or isolated TM in the following areas:

- along sections of the East Coast Main Line and Transpennine route controlled by York ROC, and for areas on the Transpennine route and West Coast Main Line controlled by Manchester ROC;
- integrated TM along the Brighton Main Line;
- integrated TM between London Liverpool Street and Colchester with isolated TM along the North London Line and to Ipswich and Felixstowe. Further infrastructure development of a dynamic loop at Witham; and
- integrated TM between London Waterloo and Woking with isolated TM along the rest of the route.

There are potential benefits for freight in the rollout of integrated or isolated TM along part of these corridors, particularly between Ipswich and Felixstowe, Ipswich to Stratford, the North London Line from Stratford to Willesden Junction High Level or Primrose Hill Junction and the route between Millbrook and Basingstoke on the Wessex route.

Further to any scheme in the early stage of development, there are a number of questions related to TM rollout that need to be considered for any successful benefits for freight to accrue or be understood.

- What are the priorities at of Network Rail regions and routes and how do these align with FNPO?
- What data is required from freight operators to assist in any successful TM rollout?

- What is the national TM long term deployment plan?
- In the case of multiple TM systems, how can integration be ensured for services that run across multiple routes or corridors?
- How will local TM regulate train services when there is a mix of local and long-distance trains?

Digital Railway are currently completing a study looking at how the implementation of TM systems in Great Britain have gone, and to examine how the operational benefits of these systems can be objectively measured. This will allow further business cases to use real operational results rather than projected benefits, as currently is the case. There is a national strategy for TM but deployment is likely to be Region led so FNPO and freight teams will need to co-ordinate with the Regions to understand where TM may be deployed and where deployment that benefits freight can be factored into Regional schemes.

Recommendation(s)

DR as part of their current study should seek to answer the following questions;

What are the priorities of Network Rail Regions and How do these align with FNPO and their customers?

What data is required from freight operators to assist in any successful traffic management rollout?

What is the national traffic management long term deployment plan?

In the case of multiple traffic management systems, how can integration be ensured for services that run across multiple routes or corridors?

How will local traffic management regulate train services when there is a mix of local and long-distance trains?

A framework should be developed between Digital Railway, FNPO and a group such as Freight Stakeholder Group for how engagement could work to effectively realise the benefits of TM, ensuring freight requirements are captured by any deployment strategy to realise operational benefits.

D.06 Traffic Management and the timetable planning process

The timetable planning process, owned by System Operator on behalf of industry, involves planning all train services into a Working Timetable (WTT). The WTT is a published document which shows all planned network moves for freight and passenger services across Great Britain and this process is carried out twice a year with a revised WTT being developed for publication in May and December.

The WTT is an iterative document, whereby each revision looks to build on the last, developing the service provision of the network to offer a more robust, efficient timetable plan that also incorporates network enhancements to delivery capacity and performance benefits for train and freight operating companies and passengers alike.

The timetable is continually developing and the importance of building reliable and achievable train paths into the plan to give operating companies a fair share of capacity whilst always looking to

improve the availability, punctuality and frequency of services for passengers and freight operators increases as the demand for capacity reaches the limit of reality on the busiest parts of the network.

Short Term Plan (STP) and Very Short-Term Plan (VSTP) train services do not form part of the WTT but allow the industry to react at short notice to demand for running trains and these train paths must work around the fixed and protected services of the Working Timetable and Strategic Capacity.

Traffic Management

TM systems are designed to be intuitive with a capability to deconflict the railway, reacting to situations which may affect the operation of running trains. This may be before services are due to run through a forward-looking approach or as disruptive events occur to resolve issues and re-plan to minimise the impact felt by TOCs, FOCs and passengers.

TM offers an opportunity to learn and continually improve on the timetable that is being produced. If for example, a route-based control centre operator is deconflicting the same issue regularly or noticing that a specific service's headway is insufficient (despite what timetable planning rules might stipulate) and this is causing a delay to trains, there must be a loop and feedback process to inform planners of the issues that exist.

This would allow industry to iron out errors, incrementally improve performance and ultimately provide a better service to passengers and freight end users. It would require collaboration between operational staff, planning teams and TOCs and FOCs and is something which should be considered in more detail. Additional work is recommended here to understand the full benefits that could be realised.

Timetable Development Project

The Digital Railway team with input from Capacity Planning (System Operator) are working on a project looking at the interaction between digital technology and the timetable planning process. This work aims to understand the changes that Digital Railway will have on production and delivery of the timetable and how digital technologies can be used to inform industry on how the timetable is performing, using the technology to feedback into the process and drive network capacity benefits. This may drive changes to Timetable Planning Rules (TPR) and how Network Rail approaches the planning process more widely and the report into the findings from this work is due in December 2019. The recommendations from this work, which will not be the final detailed design for the agreed way in which a feedback loop will operate but will aim to identify and document all the steps and considerations that need to be made to implement a feedback loop in the most successful way, should be considered in the context of this report to establish a forward strategy for the industry.

Traffic Management used effectively across the network, with the right feedback loops available and an in-grained understanding within the operator community of the benefits of providing this feedback, has the potential to drive timetabling improvements, which will bring with them performance and capacity gains. Industry should invest time and effort in establishing meaningful and manageable feedback systems, streamlining processes and allowing for collaborative working between planners and operators to exploit the opportunities that present themselves fully. The findings from the Timetable Development Project should be used to provide direction for industry, with further work required to define roles and accountabilities, the implementation of the correct technology and systems to enable TM and the timetable planning process to align seamlessly.

A user's experience of operating a TM system lends itself naturally to feedback to the planning process and the potential of this to improve and provide robustness to the timetable must be exploited where possible. The key findings and recommendations from the December report should be considered when identifying a strategy for moving forward.

Recommendation

A strategic forum such as Freight Stakeholder Group should be briefed on the findings of the Timetable Development Project upon completion, allowing relevant industry parties to engage and collaborate to put steps in place to realise benefits for FNPO.

Further workstreams

D.07 Freight facilities

Rail freight facilities either handle rail freight traffic directly or in some way support the operation of such traffic.

The former encompass terminals and railheads where traffic is loaded to or from rail; so variously located at points of traffic production, consumption or distribution, e.g. ports, wharves, quarries, mines, ports, manufacturing plants, power stations or distribution facilities. The latter include wagon or traction maintenance depots, yards, sidings and freight only lines.

All these forms of freight facility currently benefit from some form of signalling; at the very least so as to control access and egress of freight services (as in the case of freight terminals) and in some instances also controlling movements within such facilities (freight yards, good lines).

D.07.01 Traffic handling facilities

Freight traffic handling facilities are typically privately owned (whether freehold or leasehold from NR) and privately operated. Like the rail services they host, they are typically an integral part of the rail users' business and production facility.

Some facilities act as traffic origin points - quarries dispatching crushed rock or mines loading out coal or industrial minerals. Others primarily receive traffic - an urban concrete batching plant or steel distribution railhead. Still more act both to receive and dispatch traffic - port container terminals; Strategic Railfreight Interchanges (SRFI's - extensive warehousing campus with integral rail terminal); steel plants (minerals and ore inbound, finished product outbound); automotive manufacturing plants (panels and components inbound, finished vehicles outbound).

No matter the activity or commodity all such facilities will have a connection agreement with NR (typically an ORR templated contract) describing the rights of the connected party (or Adjacent Facility Owner – AFO) to enjoy connectivity to the national network and NR's responsibilities to maintain same. The connected parties can vary from operators, ports, third party sites and sites owned by customers, so a wide stakeholder engagement strategy will be required.

Connection agreements describe the extent of the NR connecting infrastructure (pointwork, plain line links, signalling apparatus etc) provided for the benefit of the connected party and other beneficiaries (as one connection can serve multiple facilities) with the functionality to provide for the control and access / egress of rail traffic to and from the facility.

Inbound freight trains serving such facilities will be routed and controlled by the signaller up to the point of connection. Movement beyond that point will be controlled by the operator of the facility (either the AFO or their nominated operating agent). Clearance of the signal controlling movements into the facility may be conditional upon 'acceptance' of the train by groundstaff (a plunger or similar linked to the signalling system), or the signaller may be at liberty to signal a train straight in (the facility operator being responsible for keeping such an arrival route clear of traffic).

Outbound movements from the freight facility onto the network will always be controlled by the signaller with a departure signal located at the point of connection. The driver or operator will bring an outbound train up to that point then advising the signaller when the train is ready to depart.

Maps of freight facilities can be found on the Network Rail website. Appendix 3 shows the locations of existing and proposed likely SRFI's.

D.07.02 Traffic supporting facilities

Freight only lines

Freight only lines are those lines routinely utilised by freight traffic only and ordinarily subject to a signalling system suited only to exceptional passenger train operation. Freight only lines typically provide a link to a freight traffic facility some distance from the mainline, or provide a diversionary or avoiding route for freight traffics between two sections of mainline. They may be privately owned and operated but the majority are network facilities.

This category would also extend to cover NR goods lines or goods loops adjacent to main lines. These are employed in the regulation of freight traffic; freight trains being timetabled to route into such lines to enable faster services to overtake.

Depending on traffic volume and linespeed, freight only lines may feature signalling control of train access and egress only with no intermediate control or may be fully signalled throughout their extent.

Wagon and Locomotive depots

These are locations where locomotives and wagons receive servicing, repair or overhaul. This includes Traction Maintenance Depots (TMDs) where locomotives are stored, maintained and repaired when not in use and wagon repair depots (WRDs) undertaking the same function for wagons. This category also extends to those sites dedicated to rolling stock storage, end of life dismantling or manufacture.

They are privately owned (freehold or leasehold from NR) by FOCs, manufacturers or other specialist engineering concerns. Like terminals, they will be subject to connection agreements and the signalling control procedures will be similar also.

Yards and sidings

At privatisation, the majority of legacy freight yards were vested under long leasehold arrangements with one or other of the original FOCs. However, today those in regular use for commercial freight traffic are NR owned and operated, frequented by the multiple FOCs operating nationwide.

NR's freight operating strategy has seen the advent of Nodal Yards, located at strategic geographic locations. Nodal Yards act as freight traffic staging and regulation points at the confluence of adjacent route sections, enabling effective management of freight traffic flows and better exploitation of end-to-end freight path components.

Realised either through the redevelopment of legacy facilities (Ipswich) or acquisition of FOC lease interest (Wembley, Doncaster Up Decoy) they are effectively a grouping of full length (so 600-800m standage per line) parallel goods lines. Nodal Yards feature signaller-controlled access and egress and occupancy is subject to a yard plan derived as part of the wider timetabling process; the main functions and principles of the yard are to provide freight recess, regulation, relief and run-round. NR plans to realise further Nodal Yard capability variously at Ripple Lane, Peterborough, Crewe, Eastleigh, Bescot and Mossend.

Nodal Yards do not host extensive marshalling or shunting operations, by design relative simplicity of operations (at most loco detachment / attachment or simple train division or joining), lend

themselves to Driver Only operation and feature full signaller control of movements in or out of each line.

NR itself relies upon a nationwide network of yards dedicated to the provision of its engineering haulage services; Whitemoor, Eastleigh, Bescot et al. Termed local distribution centres (LDC's), they are located at longstanding freight yards and are focused on the stabling and marshalling of trains that serve engineering possessions. The trains serving such possessions convey materials (sleepers, rails, ballast) and spoil capacity and their compositions are tailored to each specific worksite and so, unlike Nodal Yards, LDC's feature extensive traditional groundstaff controlled shunting activity within their extent.

Whilst such facilities are NR's freehold, the specialist operations within such facilities are subject to contract with a FOC selected under tender with the LDC facility itself being under lease to same. Access and egress to /from LDCs will be under signaller control whilst movements within LDCs are routinely entirely under the control of groundstaff along with any internal yard signalling or remotely controlled pointwork.

Network sidings, where not part of a wider yard complex, are typically utilised for the ad hoc stabling of commercial freight services, accommodation of on track plant (tampers, stoneblowers etc). In some instances, sidings used for un/loading freight traffic within a terminal facility are retained by NR and so are part of the network – typically these instances arise at NR's freight campus facilities where a number of end user tenants utilise a common unloading facility so obviating the need for duplicitous and space hungry siding provision for each tenant.

Network sidings are akin to freight facilities in that they will typically just feature signals controlling movement in from the mainline (with or without acceptance control) and movements outward onto the mainline.

D.07.03 Digital Railway programme freight facility considerations

All the types of freight facility discussed above currently benefit from some form of signalling; at the very least so as to control access and egress of freight services and so the continuation of the existing level of operational functionality and flexibility under a digital system is a pre-requisite.

By virtue of existing connection agreements such operational functionality and flexibility as provided by the described connecting infrastructure is a regulatory given. Connection agreements also detail the charge levied by NR on the connected party in respect of the maintenance of the connection, such charges will be subject to review in the light of changes to those physical, maintained, elements post-digital implementation.

The opportunity to enhance the operational functionality and flexibility afforded by digital implantation should also be considered for each freight facility.

- Removal of capacity restrictive controls on freight only lines that permit only one train in / one train out.
- Provision of facing movements into a facility otherwise typically served by stopping and propelling in.
- Removal of shunter acceptance switches so enabling NR control of movements into facilities without reliance on groundstaff attendance & acceptance (so reducing network performance risk).
- Removal of length restrictive Limit of Shunt indications, so enabling operation of longer services.
- Dynamic occupancy planning of Nodal Yards under traffic management systems.

For each freight facility, a thorough understanding of the current operational functionality will be required and an informed appraisal of potential enhanced functionality that might reasonably be achieved.

Recommendation(s)

As a minimum current functionality between freight facilities and the GB rail network needs to be maintained when digital railway solutions are implemented.

Digital Railway and consequently regions and routes to continue considering the operating requirements of all freight facilities to fully integrate digital technology to achieve maximum benefits.

All deployments taken forward between Digital Railway and the Network Rail routes will require communication with FNPO and AFOs from freight facility sites to understand the implementation timetable and impact of enhancements.

In relation to TM, the development of Nodal Yards offers better regulation of freight services. As TM deployment plans become finalised, it is important to recognise where technology can assist train regulation further. The Digital Railway study outlining the operational benefits of previous trials due in spring 2019 can offer guidance to understand the viability of systems in this space.

D.08 National passenger operators

This workstream focused on the key considerations of national passenger operators, noting that there are a number of concerns to be addressed but also opportunities to realise the benefits of digital technology. Many of the concerns and benefits mirror those relevant to the freight industry and are in common with other passenger trains operators also.

DR offers great opportunity to long distance, cross boundary operators. Like freight services, there are significant performance benefits to be realised from a fully integrated, nationwide digital network. National operators, namely CrossCountry Trains and Caledonian Sleeper, run trains for significant distances and often cross route boundaries, clocking up some of the most miles covered in a single journey by any train company operating services on the GB network. This high mileage clearly presents many interaction opportunities and interaction with other train services has an influence on performance so is important to consider when examining this measure.

CrossCountry Trains operate services connecting many of the major cities across Britain, serving a total of 131 stations well spread from north to south. With Birmingham acting as CrossCountry's main hub, it serves 6 of the 7 largest cities in the UK (excluding London). Passengers, should they so choose, can travel the 774 miles between Penzance and Aberdeen or use the service for shorter or commuting journeys. CrossCountry trains also serve several UK airports. Appendix 4 contains a map of the CrossCountry Trains network.

Caledonian Sleeper offer a Highlander and Lowlander route. With the Highlander services departing from Fort William, Inverness and Aberdeen they call at a number of Scottish stations before journeying to London Euston. The Inverness service takes a total of around 11 hours to reach London overnight. Similarly travelling northbound, you can leave Euston for a circa. 12-hour journey, with the train splitting at Edinburgh for onward travel to the same three locations further north.

The Lowlander route operates between Glasgow and London Euston and Edinburgh and London Euston. The two trains join together at Carstairs for onward travel. The reverse happens on the

northbound service, with Carstairs again acting as the journey point where the consist alters, with the train splitting into two. Appendix 4 contains a map of the Caledonian Sleeper network.

CrossCountry Trains have a capacity and overcrowding challenge. Their services, which are typically short trains and not comparable to the long Virgin or London North Western train services, are used by different markets and therefore have a wide-reaching customer base including commuters and leisure users. Commuters mean peak times are busy but CrossCountry's appeal to leisure travellers also means that typical peak and off-peak demand is difficult to predict, many services are busy at what would seem more obscure times too.

Improved performance is a key commitment for CrossCountry and benefits that DR implementation would bring in this area would be welcomed. Caledonian Sleeper performance is often exceptional but is perhaps not comparable to other operators due to journey lengths and speeds at which the trains run.

DR should enable performance improvements and mitigate capacity challenges. Digital in-cab signalling promises to be more reliable, more services could run closer together (albeit significant investment in additional fleet would have to support this) and through TM, disruption can be managed more quickly and effectively. All of this could help a national passenger operator to provide a better service for its customers, a service that's more resilient to disruption and infrastructure failures, and one with more trains and more journeys offering better travel options and more space on its carriages to help with overcrowding.

Areas of consideration

The impact of train regulation is often felt worst on long distance services, where delays can increase incrementally over the duration of the journey. Regulation of cross network traffic to optimise punctuality is difficult and impacted by the regulation decisions made, case by case, across the network. TM must be utilised in an unbiased and impartial way, where the best interests of the operational railway are at the forefront of a user's priorities. The way in which the tool operates allows for this and nothing currently suggests an operator would not act in such a way.

The key benefit of DR, that of being able to run more services closer together through ETCS, can bring benefits to all train operators and customers alike. This creates an ability to run more trains on the railway and when disruption strikes the options open to a passenger should in theory be improved, with more services running and more ways to mitigate perturbation through increased onward travel options, albeit effective performance management will be required to realise the benefits of this. National Operators need to be recognised in this. If ticket acceptance during disruption is going to be truly flexible, something which passengers prioritise in such times, there must be a fluid approach to this, one that does not exclude this type of service provider or its customers from changing travel plans and boarding other operator's services should they need to.

The most prominent of concerns for a national passenger operator, and one shared by operators of all types when considering digitalisation of the railway is the ETCS deployment plan and the patchy nature of how this will be rolled-out across the GB network. This presents some key issues which we will consider in more detail here.

- Driver training and route knowledge – if a driver is expected to operate in sections of ETCS enabled infrastructure and conventional signalling on the same journey, this may cause several issues. The assumption is that conventional driver operation would remain the default option in sections where signalling remains on the track-side however, driver training may become a more complex task as each driver would need to be accustomed to the changed network and the way in which some parts of it now operate. This will be an ongoing concern that is a consequence of the ETCS upgrade strategy detailed earlier. Route knowledge of which bits of the network are digitalised and which are not, becomes an

additional challenge for a driver and may also make driver diagramming more arduous in the planning stage.

- Safety – there is a concern that confusion leading to human error could bring with it a safety risk. The intermittent deployment of new signalling equipment could lead drivers to inadvertently become distracted and confused and this may increase the chance of SPADs and other safety incidents – industry must consider this when rolling out ETCS.
- In cab fitment – for a national passenger operator's business, where trains and locomotives will be used on different routes and moved around the network to allow for the most efficient journey planning, in-cab fitment brings a real challenge. Flexibility could be lost due to certain loco's, whether they remain conventional or having been upgraded to ETCS in-cab operation, may only be able to operate on certain parts of the network, when signalling infrastructure is removed from track-side completely, should we progress to ETCS Level 3.
- Cost – significant costs are involved with the upgrade of locomotives to in-cab signalling and various questions remain about how this will be funded. Furthermore, all operators run a lean operation, they are unlikely to be in a position whereby they could have a number of their vehicles out of service for a period of time whilst in-cab upgrades are installed, without impacting upon the performance and operation of their businesses. Service resilience may be impacted and any fleet buffer which currently exists eroded away leaving operators more vulnerable to loco break-down or unit damage, for example.

Whilst the DR programme brings a level of optimism to national passenger operators, such a major network change must be approached with caution and there are areas for further development. A priority consideration is how a business case and renewal-based approach to ETCS implementation will work for a service operator who runs trains over various routes and across region and route boundaries. National passenger operators will keenly adopt new practices which bring with them performance and capacity benefits, noting the specific opportunity here when considering the length of journeys these operators do often make. National operators, like all train operating companies and other parts of industry need to be involved in decision making and the roll-out of digital technologies, and their concerns around the long-term upgrade plan and associated locomotive fitment programme should not be ignored.

Strategy and further clarity is required when considering how national operators will run trains on a bit part ETCS enabled network, this is a key issue for the industry and greater clarification around this point will address concerns for all TOCS and FOCs. Concerns around performance, safety, training and cost exist and need answers and solutions to be developed, involving relevant operating companies in decision making and infrastructure investment decisions to ensure benefits are realised and those who operate trains on a non-route specific basis are not discounted from the potential of digital technologies to drive improvements and capacity generation on the GB rail network.

Recommendation

The CrossCountry franchise, which is due for renewal in 2022, should specify that the successful bidder provides ETCS compatible fleet (retro-fit or new), to enable a digital CrossCountry network.

Part E: **Conclusion**

This report has set out a number of recommendations for the ways in which FNPO, System Operator, customers, regions and industry should work together to enable DR benefits. for FNPO customers and end users.

FNPO services operate differently to most. Freight trains often travel long distances across several route boundaries and from and between many areas of the UK. National passenger services do not have a priority route or specific geographical ties in the same way that other passenger service providers do, albeit they do of course only call at stations that their service plan dictates. It is because of this that when considering the implementation of the digital technologies, deployment plans should be aligned so that benefits are fully realised for all operators rather than just local operators. The current approach risks delay to benefits being realised for freight and national passenger operators and could impeded benefit realisation for TOCs.

This report has set out to identify the key considerations, concerns and areas for further work or where further clarification of impacts is required, drawing assumptions and recommendations on how digital technology should be implemented and how the FNPO community must be involved in the process. This is important to ensure that freight and national passenger train operators are integral to the roll out programme so that they are able to reap the capacity, performance and safety benefits promised by the modern technologies.

Below is our view on the top 3 priority recommendations, followed by all the other recommendations contained within the report;

Top 3 Recommendations

Recommendation(s)

Whilst transitions are not expected to create increased workload the following questions should be assessed and answered by the Group Digital Railway team and Technical Authority;

What are the safety risks of transitioning between ETCS level 2 and conventional signalling areas?

How many transitions in a single journey are deemed acceptable and safe?

Recommendation(s)

The DR SR&I workstream needs to continue to engage and work with FOCs to deliver mutually acceptable ways forward.

Industry, via RSSB should support a project looking at the most appropiate braking curves to use for freight.

The Freight Stakeholder Group via the operator sub group, will continue to manage engagement with the DR team on braking curves and data entry.

Recommendation(s)

Business Cases need to be developed to support the funding for continuation of this programme of works to allow full fitment of freight locomotives. FNPO, Group Digital Railway and the DfT should continue to work together to identify funding requirements and a timeframe for completion of the work.

The freight in cab fitment programme should investigate how it could align with the decarbonisation challenges the rail industry is facing. There may be some overlap in new freight loco's being required to meet the decarbonisation challenge which could be specified with ETCS equipment as part of a new build order.

All Other Recommendations

Recommendations

Scotland Region should consider the acceleration of implementation of ETCS at Carstairs Junction to align with ETCS implementation on the remaining WCML north of Crewe in order to provide continuity of signalling and potential capacity and journey time improvements associated with remodelling Carstairs Junction.

The SFN Steering Group should consider the prioritisation of enhancements benefiting freight north of Crewe taking into account the potential alignment with proposed ECTS timescales.

Recommendation

The SFN Steering Group should work with the Digital Railway team and Eastern Region to explore whether there is a strengthened business case and efficiency from aligning ETCS deployment with the in development freight growth proposals.

Recommendation

As Eastleigh Nodal Yard is developed, Southern Region should work with FNPO to apply TM consistent with the plan for the remainder of the route.

Recommendation

The SFN Steering Group should work with the Digital Railway team and Eastern Region to explore whether there is a strengthened business case and efficiency from aligning ETCS deployment with other enhancement schemes along this line of route

Recommendation(s)

Digital Railway as part of their current study should seek to answer the following questions;

What are the priorities of Network Rail Regions and how do these align with FNPO and their customers?

What data is required from freight operators to assist in any successful traffic management rollout?

What is the national traffic management long term deployment plan?

In the case of multiple traffic management systems, how can integration be ensured for services that run across multiple routes or corridors?

How will local traffic management regulate train services when there is a mix of local and long-distance trains?

A framework should be developed between DR, FNPO and a group such as Freight Stakeholder Group for how engagement could work to effectively realise the benefits of TM, ensuring freight requirements are captured by any deployment strategy to realise operational benefits.

Recommendation

A strategic forum such as Freight Stakeholder Group should be briefed on the findings of the Timetable Development Project upon completion, allowing relevant industry parties to engage and collaborate to put steps in place to realise benefits for FNPO.

Recommendation(s)

As a minimum current functionality between freight facilities and the GB rail network needs to be maintained when digital railway solutions are implemented.

Digital Railway and consequently regions and routes to continue considering the operating requirements of all freight facilities to fully integrate digital technology to achieve maximum benefits.

Recommendation

The CrossCountry franchise, which is due for renewal in 2022, should specify that the successful bidder provides ETCS compatible fleet (retro-fit or new), to enable a digital CrossCountry network.

This work creates a platform for freight and national passenger operators to voice concerns, identify priorities and recommend strategy for the realisation of benefits from a digital railway. This report should be considered in the context of a changing industry, realising that benefits for both passengers and the economy can be gained by acting upon the recommendations here within.

Part F: **Appendices**

F.01 Appendix 1. Governance

FNPO CMSP is governed by Strategic Freight Network (SFN) Steering Group. The SFN Steering Group has a wider stakeholder base and in addition to many of the bodies also represented on the governance board (most notably DfT, RFG) includes freight operating companies, FNPO route, Office of Rail and Road (ORR) and Transport for London (TfL).

The working group which has led on or inputted directly to the workstream content, findings and recommendations, is made up of individuals from a number of the above organisations who are closely involved with the subject areas we have been investigating. Additionally, there has been representation, or input away from the meetings, by several Network Rail route teams, Digital Railway, CrossCountry Trains, Eversholt Rail and independent subject matter experts and consultants.

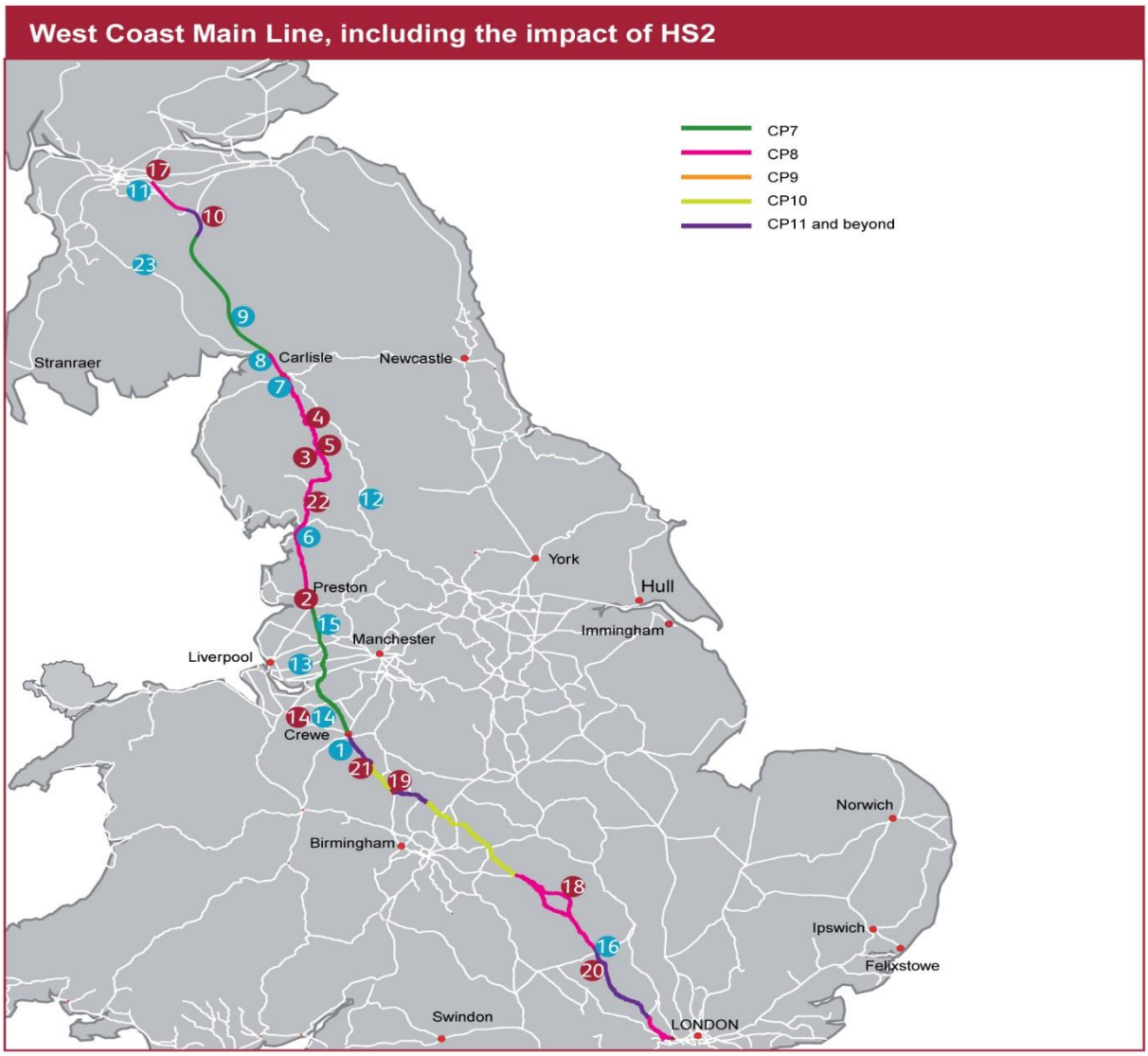
The Digital Railway Programme Board have been briefed on the work being undertaken and provided feedback on the workstream topics at the beginning of the study. whilst there has not been any formal direct governance it has been important to involve this group for information purposes.

Before being finalised this CMSP report was reviewed by each of these groups and signed off for publication. Feedback and comments have been incorporated and the report amended as required.

F.02 Appendix 2. Freight Corridors

The following maps highlight the current ETCS deployment plan by Strategic Freight Corridors alongside other potential future enhancements. These maps show the piecemeal approach and the how sections on key freight corridors do not align for benefits to be realised.

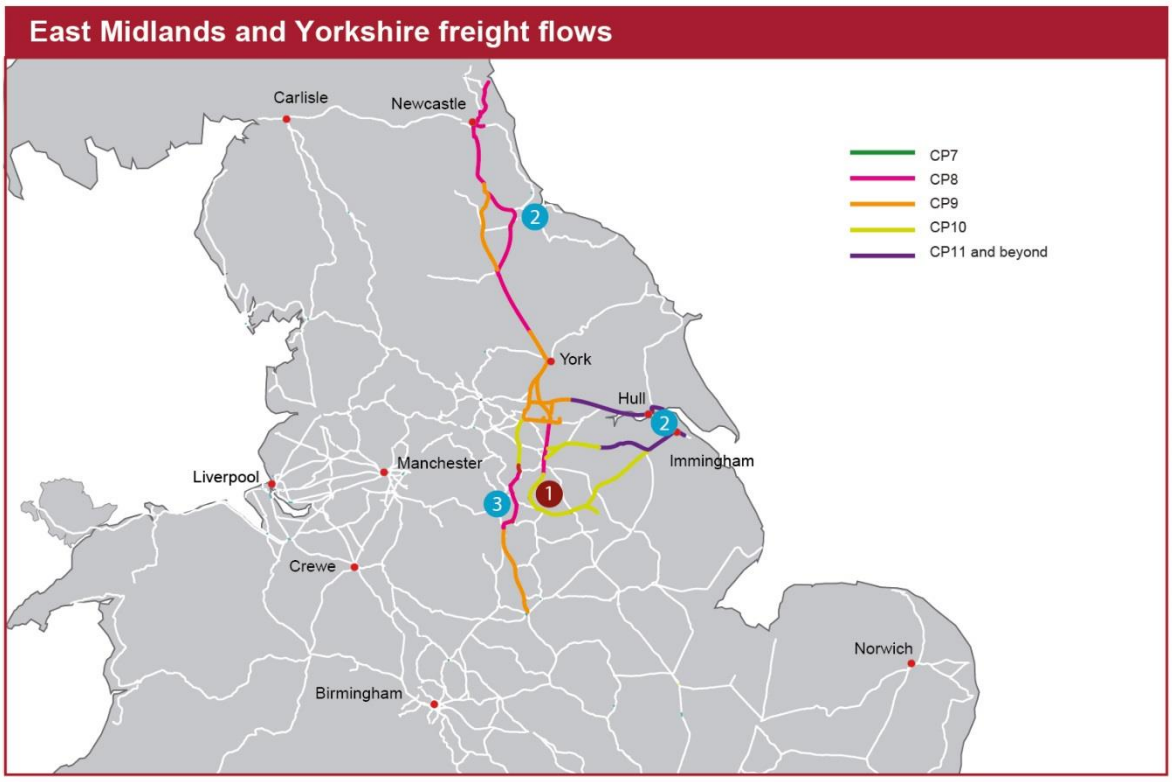
Corridor 1. West Coast Main Line (WCML), including impact of HS2 – Coloured lines represent ETCS deployment by Control Period



1	Possible Crewe Yard changes
2	Preston Station area remodelling
3	Dynamic down loop Tebay to Shap Summit
4	Dynamic up loop Carlisle to Plumpton
5	Dynamic up loop Eden Valley to Shap Summit
6	4-tracking Preston to the border
7	Carlisle Station remodelling including 4-tracking of approaches
8	3 or 4 track Gretna Jn to Floriston
9	4-tracking sections from Carlisle to Carstairs
10	Carstairs remodelling
11	Grade separation Law, Holytown and Uddingston Jns
12	Settle & Carlisle upgrade to accommodate all freight traffic
13	Acton Grange to Warrington capacity
14	Winsford to Weaver Jn interventions (2026 and 2043)
15	Wigan to Preston interventions
16	Scheme to accommodate East West Rail traffic onto the WCML
17	Gauge clearance to W12 of WCML to Grangemouth
18	Northampton Loop enhancements
19	Doubling of Stafford South Jn
20	Gauge clearance to W12 of WCML from Wembley to the Midlands
21	Gauge clearance to W12 of WCML from the Midlands to the North West
22	Gauge clearance to W12 of WCML from Wigan to Coatbridge
23	Gauge clearance to W12 of the Glasgow South Western route

Scheme	SFN Priority	Type	ETCS Deployment
Doubling of Stafford South Junction	CP6/CP7	Capacity	CP10
Preston station area capacity enhancement and remodelling	CP6/CP7	Capacity	CP7/CP8
Dynamic down loop Tebay to Shap Summit in Cumbria	CP6/CP7	Capacity	CP8
Dynamic up loop between Carlisle and Plumpton (near Penrith)	CP6/CP7	Capacity	CP8
Remodelling of Carstairs Jn to improve freight regulation	CP6/CP7	Capacity	CP11+
Reduction of headways on Northampton loop and remodelling of Northampton station to allow higher line speeds	CP6/CP7	Capacity	CP8
WCML W12: Midlands Terminals to Wigan / Trafford Park	CP6/CP7	Gauge	CP7, CP10, CP11+
WCML W12: Wembley to Midlands terminals	CP6/CP7	Gauge	CP8, CP10, CP11+
W12 between WCML (Coatbridge) and Grangemouth. Potential cost range: less than £50m (2017)	CP6/CP7	Gauge	CP9
W12 between Wigan and Coatbridge	CP6/CP7	Gauge	CP7, CP8
Northampton station speeds	CP6/CP7	Capability	CP8
West Coast West Midlands to North West speed	CP6/CP7	Capability	CP7, CP10, CP11+
West Coast Heavy Axle Weight South	CP6/CP7	Capability	CP8, CP11+
West Coast 775m train length North West to Scotland	CP6/CP7	Capability	CP7, CP8, CP11+
West Coast 775m train length West Midlands to North West	CP6/CP7	Capability	CP7,CP8,CP10,CP11+
West Coast West Midlands to North West speed improvements (including at Crewe and Warrington)	CP6/CP7	Capability	CP7, CP10, CP11+
West Coast South loop entry and exit speed improvements (including at Wembley Yard)	CP6/CP7	Capability	CP8, CP11+
West Coast South speed improvements (for Heavy Axle Weight traffic) (including at bridge near Wolverton)	CP6/CP7	Capability	CP8, CP11+
West Coast North loop entry and exit speed improvements (including at Eden Valley and Tebay)	CP6/CP7	Capability	CP8
Possible impacts on freight yards in the Crewe area due to works to enhance capacity for passenger and freight services. This takes an opportunity for major improvements in conjunction with HS2 Phase 2a and replacement of life expired assets.	CP8 & beyond	Capacity	CP7, CP11+
Four-tracking north of Preston to the Border or investigation into the feasibility of a new two-track railway. Strategy for further development of infrastructure interventions to be undertaken in conjunction with and agreed with DfT / HS2 Ltd, to enable the development of a long term solution to capacity and Anglo-Scottish connectivity / journey time needs.	CP8 & beyond	Capacity	CP8
Carlisle station remodelling, including four-tracking both approaches, new platforms and segregating passenger and freight flows through the station	CP8 & beyond	Capacity	CP8
Three or four-tracking from Gretna Junction to Floriston (Cumbria).	CP8 & beyond	Capacity	CP8
Four-tracking sections from Carlisle to Carstairs.	CP8 & beyond	Capacity	CP7
Grade separate of Law, Holytown and Uddingston Junctions southeast of Glasgow.	CP8 & beyond	Capacity	CP8
Settle and Carlisle upgrade to accommodate intermodal freight traffic.	CP8 & beyond	Capacity	CP10
Acton Grange to Warrington capacity - enable long-term growth for interurban connectivity at Warrington and provide additional capacity to accommodate freight growth	CP8 & beyond	Capacity	CP7
Winsford to Weaver Junction (near Runcorn) interventions. Option 1: four track between Winsford and Weaver excluding Weaver, to deliver an extra 1tph freight and 1tph passenger paths (off-peak); Option 2: four track between Winsford and Weaver including Weaver, to deliver and extra 2tph freight and 3tph passenger paths (off-peak); Option 3: Electrification of diversionary route via Middlewich (Cheshire) and potential further enhancements.	CP8 & beyond	Capacity	CP7
Interventions between Wigan and Preston, four-tracking from Springs Branch Junction to Euxton Junction, additional terminating platform capacity at Wigan, grade separation of Euxton Junction, six-tracking from Farrington Curve Junction to Preston, additional platform capacity at Preston, realign Preston throat so that flows split between Blackpools, freight and long distance. The intervention supports a number of additional passenger services running in the area as well as 3 additional freight services.	CP8 & beyond	Capacity	CP7
Scheme to accommodate East West Rail traffic onto the WCML. Grade separation at Denbigh Hall South Junction, near Bletchley, and additional platform capacity at Milton Keynes Central	CP8 & beyond	Capacity	CP8, CP11+
Gauge clearance to W12 of the Glasgow South Western route	CP8 & beyond	Gauge	CP7, CP8
Aspiration: to increase maximum freight speed from 75mph to 90mph to help reduce total journey time. This could necessitate the use of electric traction. To maximise benefit from increased velocity, freight to run on fast lines when possible (i.e. off peak, night-time).	CP8 & beyond	Capability	Various

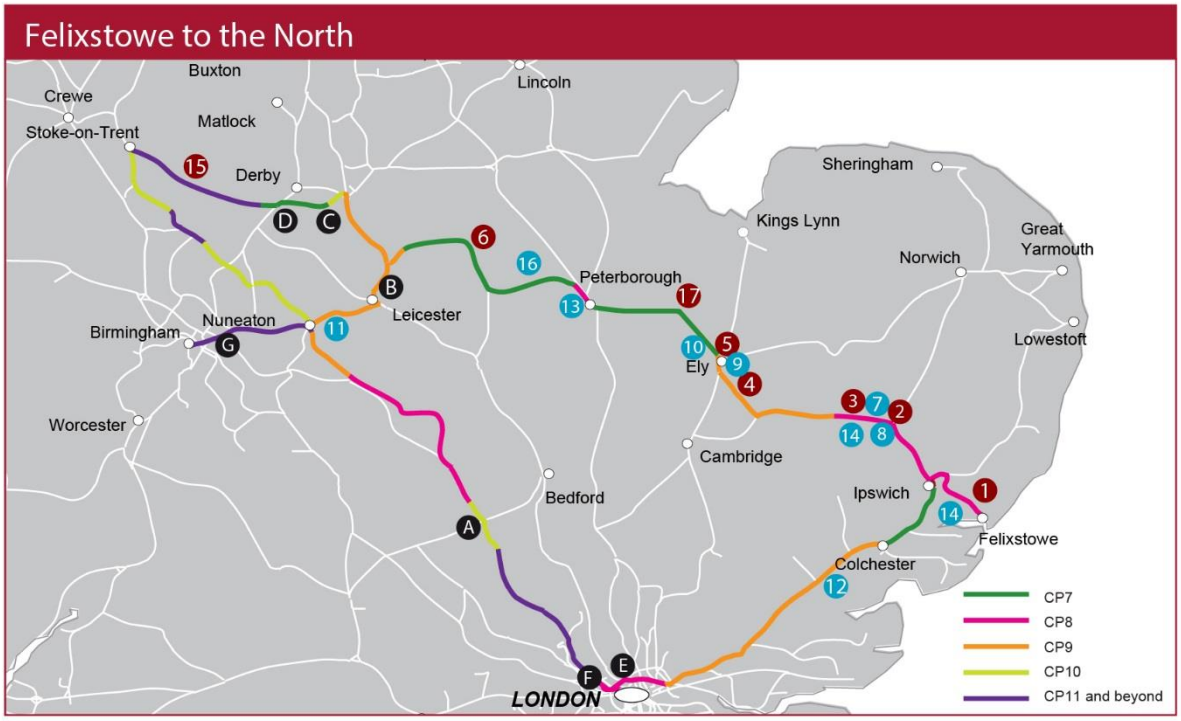
Corridor 2. East Midlands & Yorkshire – Coloured lines represent ETCS deployment by Control Period



1 Gauge clearance to W12 of South Yorkshire Joint Line
2 Diversionary access for Immingham and Teesport
3 Electrification of Yorkshire freight routes

Scheme	SFN Priority	Type	ETCS Deployment
Gauge clearance to W12 of South Yorkshire Joint Line between Doncaster and Gainsborough via Worksop, to enable W12 traffic to access Rossington intermodal terminal. Potential cost range: £15m to £35m.	CP6/CP7	Gauge	CP8
Aspiration: to remove sections of low line speed, to enable freight to achieve greater average speed	CP6/CP7	Capability	CP8 TO CP11+
East Coast North speed improvements (including on the ECML in the Thirsk area and between King Edward Bridge Jn and Sunderland)	CP6/CP7	Capability	CP8
East Midlands & Yorkshire speed improvements (for Heavy Axle Weight traffic) (including on South Yorkshire Joint Line)	CP6/CP7	Capability	CP8 TO CP11+
Diversionary access for Immingham and Teesport.	CP8 & beyond	Capacity	CP8, CP11+
Electrification of Yorkshire freight routes: Tapton Junction to Masborough and Nunnery Main Line Junction, via Beighton Junction; Beighton Junction to Woodburn Junction; Hare Park Junction to Leeds Stourton terminal reception Line; Stourton terminal to Whitehall Junction.	CP8 & beyond	Capacity	CP8, CP9, CP10
Aspiration: to enhance gauge clearance for York and Newcastle stations, providing W12 clearance for additional track through central York and central Newcastle approaches	CP8 & beyond	Gauge	CP8, CP9
Aspiration: to increase average speed in conjunction with loops, in line with East Coast Connectivity. This could have substantial benefits to terms of capacity and resilience.	CP8 & beyond	Capability	CP8 TO CP11+

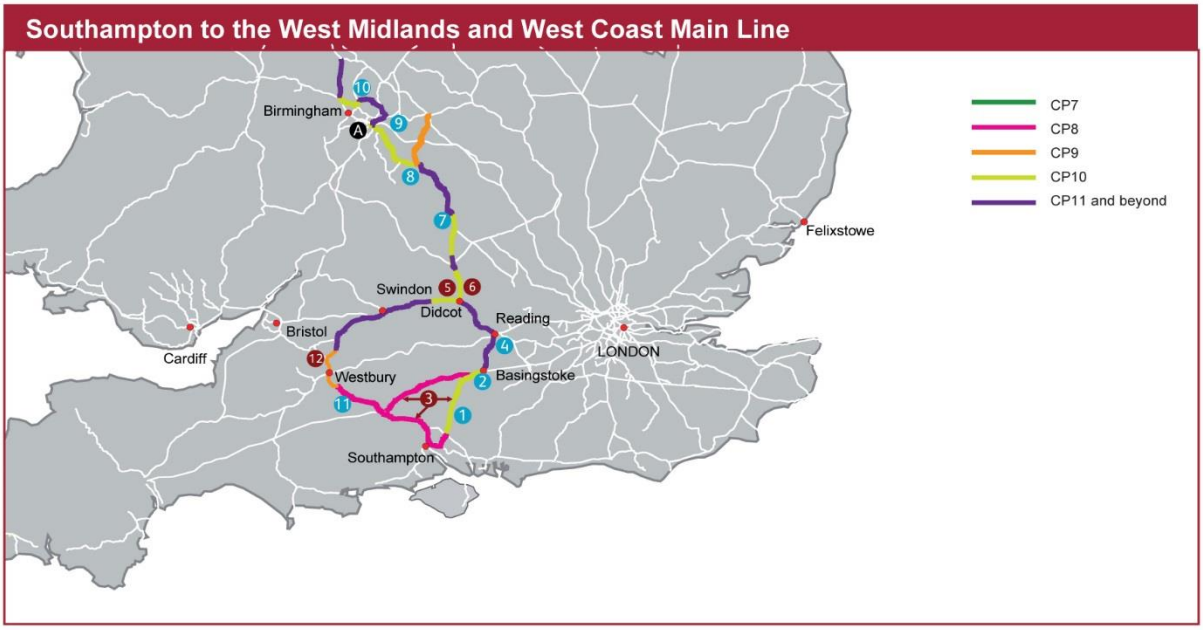
Corridor 3. Felixstowe to West Midlands and the North – Coloured lines represent ETCS deployment by Control Period



1	Further doubling of Felixstowe Branch Line	14	F2N Phase 3: to accommodate long term growth
2	Haughley Junction loop facility	15	Gauge clearance to W12 of Syston to Stoke
3	Bury St Edmunds headway reductions	16	Electrification of the route via Ely
4	Partial or full doubling of Soham to Ely	17	Gauge clearance to W12 of the route via Ely
5	Ely infrastructure works		
6	Signalling enhancements Syston East Junction – Peterborough area	A	Scheme to accommodate East West Rail traffic on to WCML
7	Haughley Jn 4 tracking	B	Leicester Area Capacity
8	Haughley Jn grade separation	C	New line linking Stenson Jn to MML
9	Grade separation and additional tracking around Ely	D	Stenson Jn to Sheet Stores Jn Line speed Improvement
10	New Ely avoiding line	E	Modification of signalling block at Hampstead Heath Tunnel
11	Track and signalling enhancements Leicester to Nuneaton	F	Freight regulation loop at Kensal Rise
12	Passing loop between Colchester and Witham	G	Water Orton area interventions
13	4-tracking Werrington Jn to Peterborough		

Scheme	SFN Priority	Type	ETCS Deployment
A loop facility at Haughley Junction (near Stowmarket), including doubling of the junction	CP6/CP7	Capacity	CP7
Headway reductions at Bury St Edmunds through improvements to signalling	CP6/CP7	Capacity	CP7, CP9
Doubling between Ely and Soham	CP6/CP7	Capacity	CP9
Infrastructure works at Ely such as level crossings enhancements and additional tracking	CP6/CP7	Capacity	CP8, CP9
Signalling enhancements in the Syston East Junction – Peterborough area	CP6/CP7	Capacity	CP7, CP8
Gauge clearance to W12 between Syston and Stoke. This scheme is committed in CP6 and is therefore included in baseline. Potential cost range: £20m to £30m.	CP6/CP7	Capability	CP8
Gauge clearance to W12 of cross country route via Ely (subject to emerging market demands)	CP6/CP7	Capability	CP7, CP8, CP9
West Midlands train lengthening to 775m (including Nuneaton to Lawley Street)	CP6/CP7	Capability	CP11+
Aspiration: removal of sections of low line speed to enable freight to achieve greater average speed	CP6/CP7	Capability	Clarify specific areas
Anglia speed (including in Ely area)	CP6/CP7	Capability	CP7, CP8, CP9
Either: some four-tracking between Haughley Junction and Ipswich. Or: Grade separation at Haughley Junction.	CP8 & beyond	Capacity	CP7
Grade separation at Ely North and Dock Junctions as well as additional track around Ely.	CP8 & beyond	Capacity	CP8, CP9
A new avoiding line at Ely.	CP8 & beyond	Capacity	CP8, CP9
Track and signalling enhancements between Leicester and Nuneaton.	CP8 & beyond	Capacity	CP9
A passing loop between Colchester and Witham.	CP8 & beyond	Capacity	CP9
Four-tracking Peterborough to Werrington Junction, north of Peterborough.	CP8 & beyond	Capacity	CP7
Further route-wide capacity and capability programme to enable long-term growth.	CP8 & beyond	Capacity	CP7 TO CP11+
Electrification of the the entire route, via Ely. Medium term.	CP8 & beyond	Capacity	CP7, CP8, CP9
Aspiration: to run electric traction on both routes	CP8 & beyond	Capability	CP7 TO CP11+
Aspiration: to increase maximum freight speed from 75mph to 90mph to help reduce total journey time. This could necessitate the use of electric traction	CP8 & beyond	Capability	Further clarity required

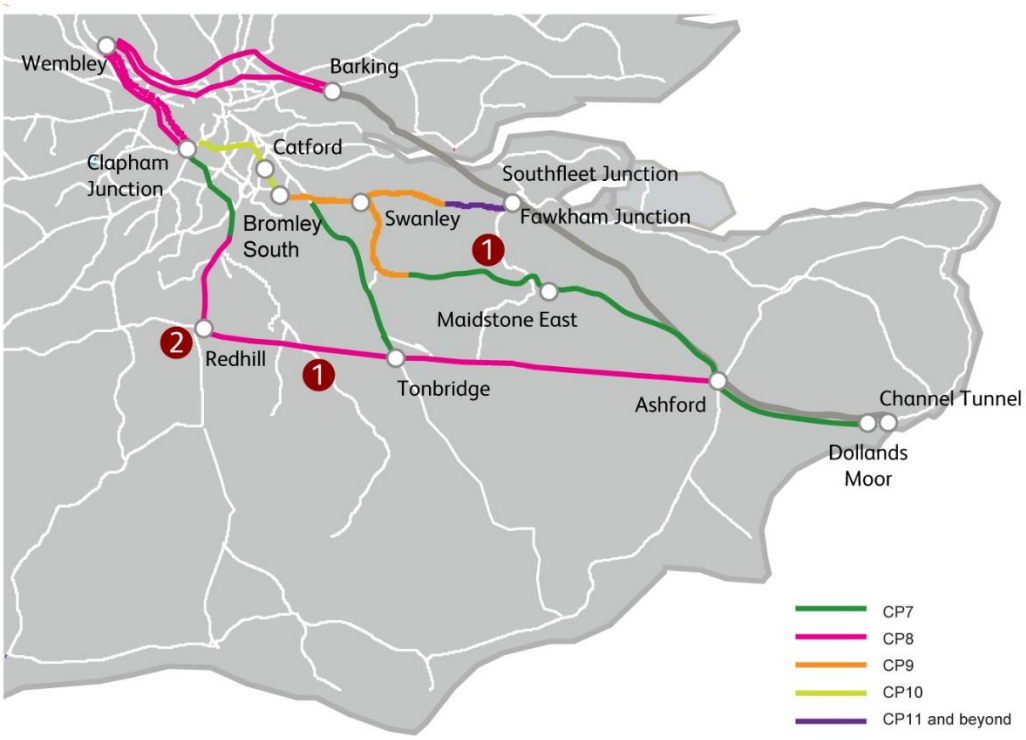
Corridor 4. Southampton to the West Midlands and the West Coast Main Line - Coloured lines represent ETCS deployment by Control Period



1	Passing loop between Eastleigh and Basingstoke
2	Grade separation at Basingstoke
3	Assuming OLE electrification of Southampton to Basingstoke, provision of electrified diversionary route via Andover
4	Capacity enhancements between Southcote Jn and Oxford Road Jn
5	Grade Separation at Didcot East and Oxford North Jns and capacity improvements at Oxford Station
6	Grade separation at Didcot East Jn, capacity improvements Didcot-Oxford and Oxford Station
7	Banbury loops
8	Leamington Spa station remodelling
9	Water Orton area interventions
10	Sutton Park Line electrification
11	Gauge clearance to W10 of diversionary route via Westbury and Melksham
12	Gauge clearance to W8 of Bradford Jn to Bathampton Jn
A	Electrification of key freight terminals in the West Midlands

Scheme	SFN Priority	Type	ETCS Deployment
Electrification of the diversionary route from Southampton Ports and Basingstoke via Andover	CP6/CP7	Capacity	CP8
Either: Grade separation at Didcot East Junction and Oxford area and capacity improvements at Oxford Station Or: Grade separation at Didcot East Junction, four-tracking between Didcot and Oxford and at Oxford Station	CP6/CP7	Capacity	CP10
Gauge clearance to W10 of diversionary route via and Westbury and Melksham	CP6/CP7	Gauge	CP9, CP11+
Gauge clearance to W8 between Bathampton Jn and Bradford Jn (Dundas Aquaduct)	CP6/CP7	Gauge	CHECK
Aspiration: investigations to be undertaken to support aspiration to run trains longer than 775m	CP6/CP7	Capability	Clarify specific areas
Passing loops between Eastleigh and Basingstoke. Medium term	CP8 & beyond	Capacity	CP10
Basingstoke grade separation. Medium term	CP8 & beyond	Capacity	CP10, CP11+
Capacity enhancements between Southcote Junction and Oxford Road Junction (south of Reading), including grade separation at Southcote Junction.	CP8 & beyond	Capacity	CP11+
Passing loops at Banbury.	CP8 & beyond	Capacity	CP10, CP11+
Enhanced signalling and crossovers at Leamington Spa station to enable greater use of bay platforms for passenger services.	CP8 & beyond	Capacity	CP9, CP10, CP11
Additional capacity at Water Orton including elements of four tracking and grade separation.	CP8 & beyond	Capacity	CP11+
Electrification of the Sutton Park Line, near Birmingham.	CP8 & beyond	Capacity	CP11+

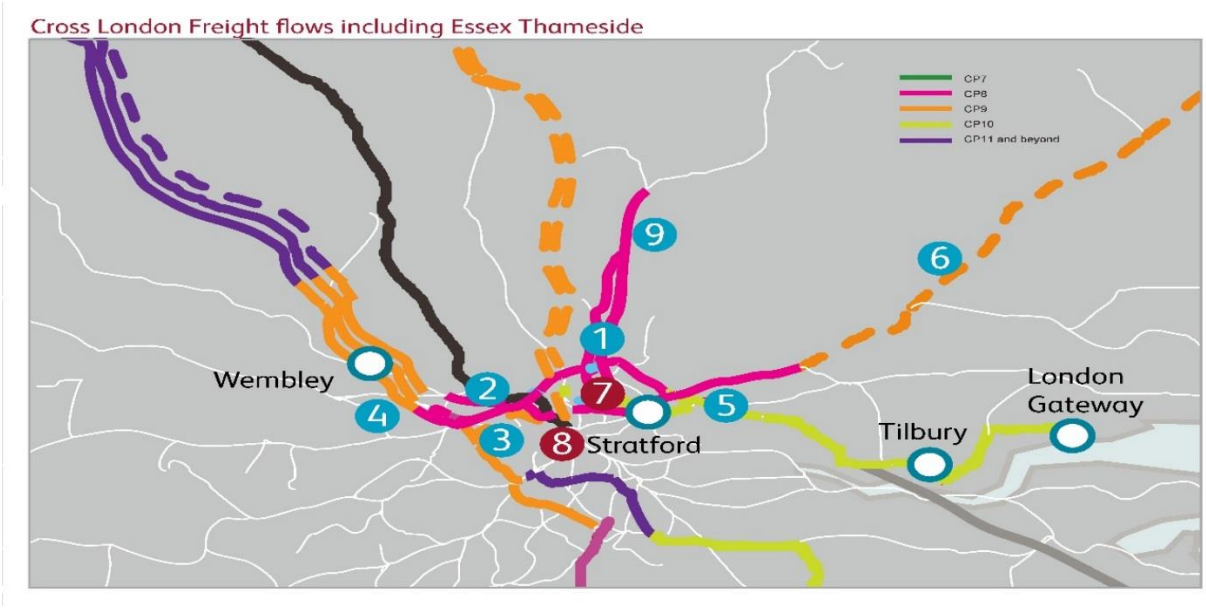
Corridor 5. Channel Tunnel freight - Coloured lines represent ETCS deployment by Control Period



Route 1: Channel Tunnel core route via Maidstone East
Route 2: Channel Tunnel diversionary route via Tonbridge
Route 3: Barking to Wembley HS1 via NLL
Route 4: Barking to Wembley Non-HS1 via GOB
Route 5: Fawkham Jn to Swanley
Route 6: Tonbridge to Bickley
Route 7: HS1

Scheme	SFN Priority	Type	ETCS Deployment
Address incompatibility issue between existing Redhill track circuit system and Class 92 locomotives	CP6/CP7	Capacity	CP8
Gauge clearance to W12 between the Channel Tunnel and Wembley via Maidstone and/or Tonbridge	CP6/CP7	Gauge	CP7, CP8, CP9

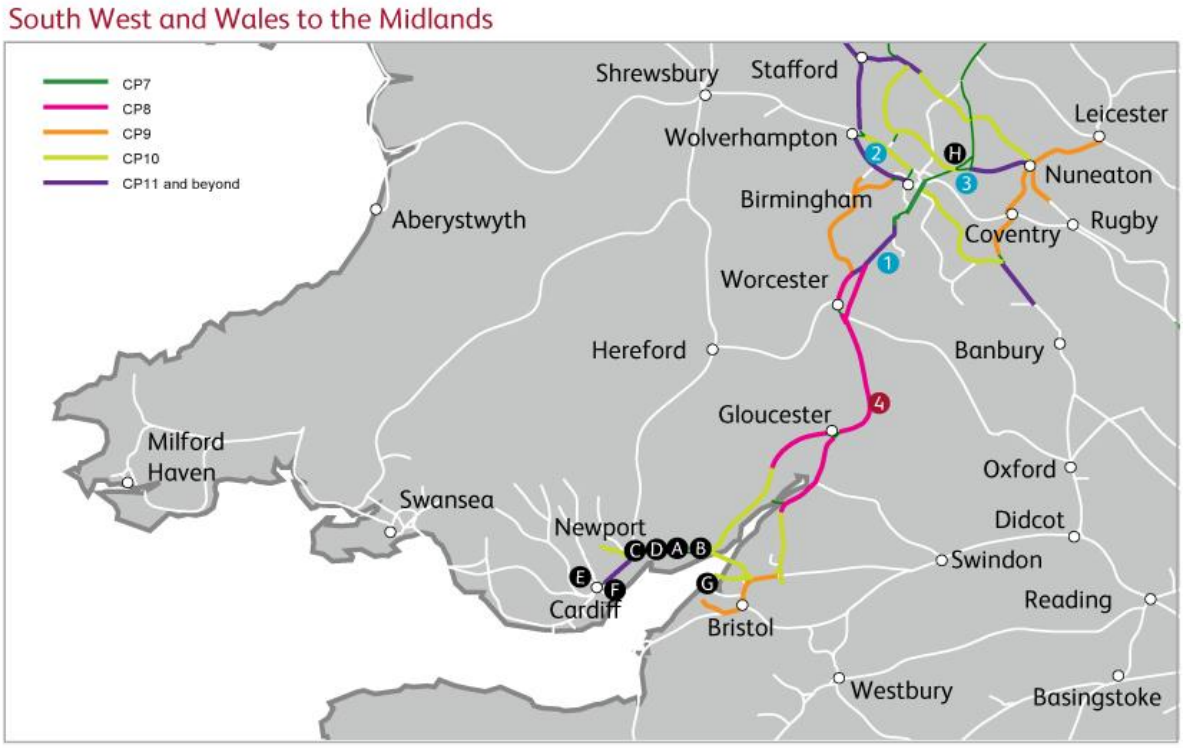
Corridor 6. Cross London freight flows including Essex Thameside - Coloured lines represent ETCS deployment by Control Period



1 Enhancements to signalling on the Gospel Oak to Barking line
2 Freight loop at Gospel Oak on the Gospel Oak to Barking line
3 Modification of signalling block at Hampstead Heath Tunnel
4 Freight regulation loop at Kensal Rise
5 Forest Gate grade separation
6 Possible Pitsea to Ingatestone rail link
7 Cross London freight capacity
8 Infill electrification between Junction Road Jn and Carlton Road Jn and to London Gateway port
9 Gauge clearance to W12 of West Anglia Main Line

Scheme	SFN Priority	Type	ETCS Deployment
Cross London freight capacity	CP6/CP7	Capacity	CP8
Infill electrification of the Thames Haven branch line and Junction Road Junction to Carlton Road Junction to deliver a new electric freight flow following completion of the Gospel Oak to Barking electrification scheme. The scheme would enable Thames Gateway traffic to operate by electric traction from the port via the Gospel Oak to Barking line to Carlton Road Junction and the Midland Main Line.	CP6/CP7	Capacity	CP8
Enhanced signalling headway on the Gospel Oak to Barking line to enable 4tph freight alongside 6tph passenger and possible new platform at Gospel Oak.	CP8 & beyond	Capacity	CP8
A westbound freight loop between Gospel Oak Junction and Upper Holloway on the Gospel Oak to Barking line.	CP8 & beyond	Capacity	CP8
Modification of the signalling block at Hampstead Heath Tunnel, to enable 4tph freight alongside 12tph passenger.	CP8 & beyond	Capacity	CP8
A freight regulation loop at Kensal Rise, to enable 4tph freight alongside 12tph passenger.	CP8 & beyond	Capacity	CP8
Grade separation at Forest Gate.	CP8 & beyond	Capacity	CP8
Investigate the feasibility of a new rail link between Pitsea and Ingatestone to facilitate routeing of Thames Gateway traffic via the Felixstowe to Nuneaton corridor.	CP8 & beyond	Capacity	CP8, CP10
London Gateway train lengthening to 775m (London Gateway to Ripple Lane)	CP6/CP7	Capability	CP10
Aspiration: to remove sections of low line speed, to enable freight to achieve greater average speed	CP6/CP7	Capability	CP8, CP10
Cross London speed improvements (between Kentish Town and Camden Road)	CP6/CP7	Capability	CP8
Cross London speed improvements (for Heavy Axle Weight traffic) (including at Kentish Town Viaduct)	CP6/CP7	Capability	CP8, CP10
W12 gauge clearance of the West Anglia Main Line	CP8 & beyond	Gauge	CP8
Aspiration: to run electric traction on all freight routes	CP8 & beyond	Capability	CP8 TO CP11+

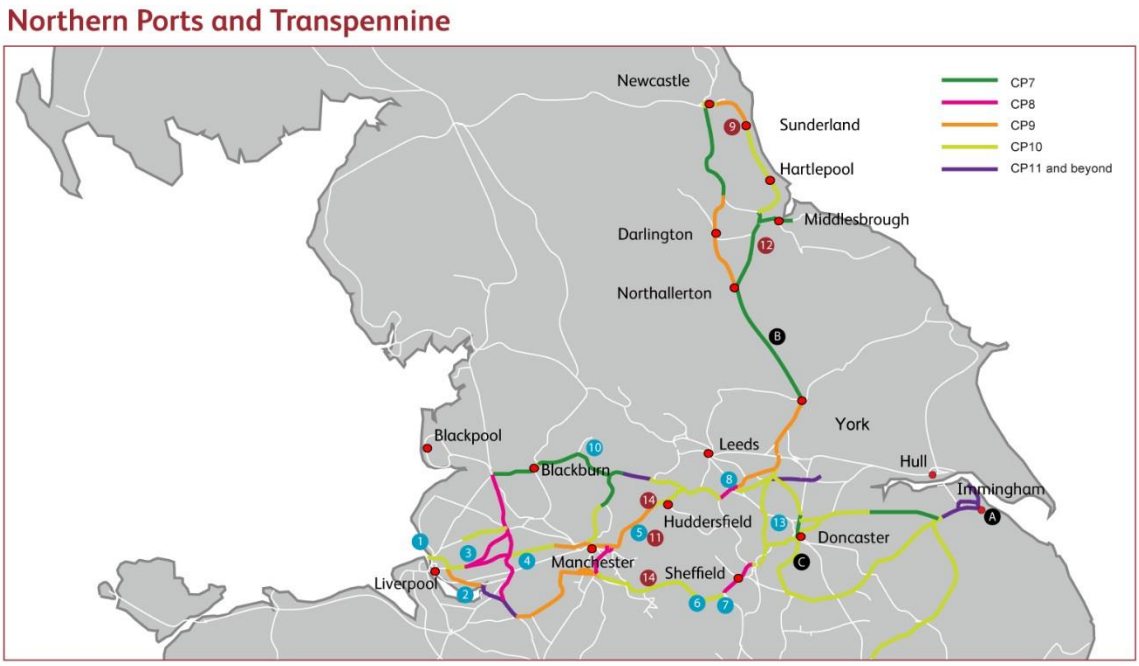
Corridor 7. South West & Wales to the Midlands - Coloured lines represent ETCS deployment by Control Period



1	Bromsgrove Corridor interventions	C	Grade separation at Maindee West Jn
2	Re-opening of Stourbridge - Walsall/Lichfield Line	D	Headway improvement between Bishton and Maindee Jn
3	Electrification of key freight terminals in the West Midlands	E	Headway improvements on main lines between Ebbw Jn and Cardiff Central
4	Gauge clearance to W10 of Bristol to Birmingham	F	Headway improvements on main and relief lines between Ebbw Jn and Cardiff Central
A	Remodelling of Bishton flyover (with flat junction) and west end of Severn Tunnel Jn	G	Electrification of Avonmouth Branch
B	Remodelling of Bishton flyover (with replacement flyover) and east end of Severn Tunnel Jn	H	Water Orton area interventions

Scheme	SFN Priority	Type	ETCS Deployment
Gauge clearance to W10 between Bristol and Birmingham	CP6/CP7	Gauge	CP7 TO CP11+
Aspiration: Remove sections of low line speed to enable freight to achieve greater average speed	CP6/CP7	Capability	CP7 TO CP11+
Western speed improvements (including Cheltenham, Worcester and Westerleigh Junction, near Bristol)	CP6/CP7	Capability	CP8
West Midlands speed improvements (for Heavy Axle Weight traffic) (including bridge near Kenilworth and at Duddeston)	CP6/CP7	Capability	CP9
To accommodate the train service identified in the West Midlands and Chilterns Route Study for 2043, grade separation would be required in the Barnt Green and Kings Norton area. High level analysis suggests that this option could support 2 freight trains per hour, up to 8tph long distance passenger and 6tph on the Cross City commuter corridor.	CP8 & beyond	Capacity	CP7, CP11+
Reopening the Stourbridge to Walsall/ Lichfield line.	CP8 & beyond	Capacity	N/A
Electrification of key freight terminals, including Lawley Street (in Birmingham), Bescot (near Walsall) and Hams Hall (at Water Orton).	CP8 & beyond	Capacity	CP7, CP10, CP11+
Aspiration: use of electric traction could potentially enable longer trains to run	CP8 & beyond	Capability	N/A
Aspiration: to run electric traction on the entire route, to enable heavier trains to operate and free up capacity on the route	CP8 & beyond	Capability	CP7 TO CP11+

Corridor 8. Northern Ports & Transpennine - Coloured lines represent ETCS deployment by Control Period



1	Bootle Branch enhancements	10	Potential Calder Valley Line enhancements
2	South Liverpool Terminals to WCML	11	Short term Transpennine Freight Capacity
3	Port of Liverpool to WCML	12	Level crossing enhancements Teesport - Northallerton
4	Chat Moss: night time access		
5	Enhancements to increase Transpennine freight capacity	13	Further gauge clearance to Yorkshire Terminals
		14	Gauge clearance to W12 of a Transpennine route
6	Hope Valley: loop at Edale	A	Diversionary access for Immingham and Teesport
7	Hope Valley: loop at Grindleford	B	Capacity interventions on ECML between York & Newcastle
8	Electrification of Yorkshire freight routes		
9	Level crossing enhancements at East Boldon and Tile Shed	C	Gauge clearance to W12 of South Yorkshire Joint Line

Scheme	SFN Priority	Type	ETCS Deployment
Level crossing enhancements on Tyne Dock branch for increased freight traffic at East Boldon and Tile Shed	CP6/CP7	Capacity	CP9
Given the changing nature of upgrades on the Transpennine routes and Transport for the North's on-going freight initiatives, increasing freight capacity and capability has been identified as a key short term requirement to enable the growth of freight on the Transpennine routes.	CP6/CP7	Capacity	CP7 TO CP11+
Level crossing enhancements between Teesport and Northallerton for increased intermodal traffic.	CP6/CP7	Capacity	CP7
Gauge clearance to W12 of a Transpennine route	CP6/CP7	Gauge	CP9, CP10 VIA DIGGLE
Aspiration: Remove sections of low line speed to enable freight to achieve greater average speeds	CP6/CP7	Capability	CP7 TO CP11+
Immingham speed improvements (at locations between Doncaster and Immingham)	CP6/CP7	Capability	CP11+
Transpennine speed improvements (for Heavy Axle Weight traffic) (including at bridge near Stalybridge)	CP6/CP7	Capability	CP8, CP9
North West speed improvements (for Heavy Axle Weight traffic) (including at bridge near Stockport)	CP6/CP7	Capability	CP8 ,CP9, CP10
North East and Humber speed improvements (for Heavy Axle Weight traffic) (including at bridge near Scunthorpe)	CP6/CP7	Capability	CP7, CP11+
East Lancashire speed improvements (Heavy Axle Weight only) (including at Lydgate Viaduct near Burnley)	CP6/CP7	Capability	CP7
Liverpool speed improvements (Bootle branch)	CP6/CP7	Capability	CP10
Line speed improvements from 20mph up to 40mph on the Bootle branch. Medium term.	CP8 & beyond	Capacity	CP10
Enabling works to support the aspiration to reach 3tph from South Liverpool Terminals to the WCML.	CP8 & beyond	Capacity	CP9
Enabling works to support the aspiration to reach 3tph from Port of Liverpool to the WCML.	CP8 & beyond	Capacity	CP10
Rearranging maintenance schedules to allow night-time access to the Chat Moss corridor.	CP8 & beyond	Capacity	CP10
Increasing Transpennine freight capacity via Diggle for Liverpool and Humber ports, including gauge clearance.	CP8 & beyond	Capacity	CP8 TO CP11+
A loop at Edale in the Hope Valley.	CP8 & beyond	Capacity	CP10
A loop at Grindleford in the Hope Valley.	CP8 & beyond	Capacity	CP10
Electrification of Yorkshire freight routes: Tapton Junction to Masborough and Nunnery Main Line Junction, via Beighton Junction; Beighton Junction to Woodburn Junction; Hare Park Junction to Leeds Stourton terminal reception Line; Stourton terminal to Whitehall Junction	CP8 & beyond	Capacity	CP7, CP10
Improved capacity and line speeds on the Calder Valley line.	CP8 & beyond	Capacity	CP7
Gauge clearance to W12 of further routes for Yorkshire terminals including: Gascoigne Wood Jn to Sherburn Jn to Colton Jn; Altofts Jn to Whitwood Jn to Sherburn Jn; Methley Jn to Whitwood Jn;	CP8 & beyond	Gauge	CP9,CP10
Aspiration: enhanced gauge clearance for York and Newcastle stations	CP8 & beyond	Gauge	CP8, CP9

Corridor 9. Midland Main Line - Coloured lines represent ETCS deployment by Control Period

1	South of Bedford enhancements: grade separation at Harpenden and Leagrave Jns
2	Bedford area enhancements incl. new platform and a new turnback
3	4-tracking Kettering North Jn to Kilby Bridge Jn
4	Leicester Area Capacity
5	New line linking Stenson Jn to the MML
6	Stenson Jn to Sheet Stores Jn line speed improvements
7	Additional turnback facility at Derby station
8	Further Peak Forest capacity
9	Additional access to Mountsorrel Aggregates Terminal
10	Dore to Sheffield capacity enhancements
11	Reopening of Matlock - Buxton line
12	Gauge clearance to W10 between London and Bedford (including cross London route infill)
13	Gauge clearance to W12 between London and Bedford (including Gospel Oak to Barking Line)

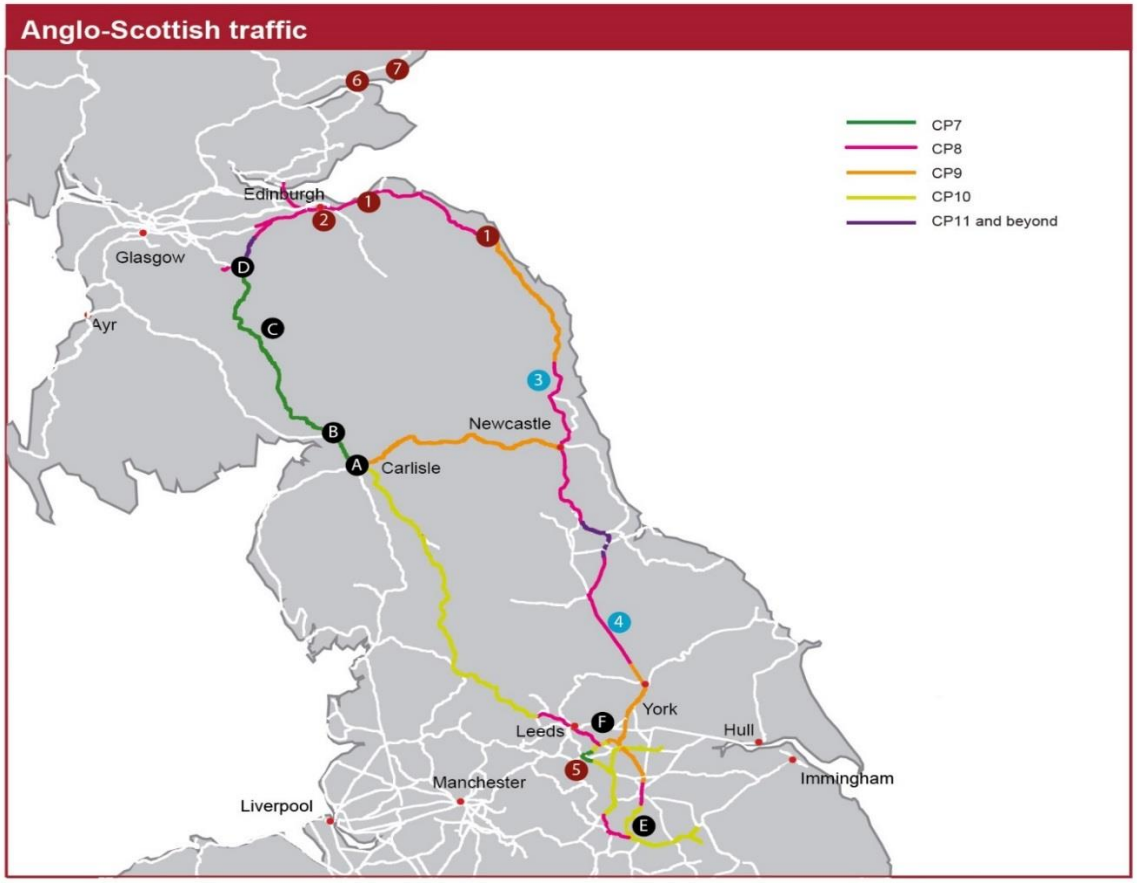
Scheme	SFN Priority	Type	ETCS Deployment
Leicester area capacity, including new platforms at Leicester station, two additional tracks between Wigston North Junction and Syston East Junction, and grade separation at Wigston North Junction.	CP6/CP7	Capacity	CP9
Gauge clearance to W10 between London and Bedford (including cross London routes infill)	CP6/CP7	Gauge	CP7, CP8
Gauge clearance to W12 between London and Bedford (including Gospel Oak to Barking line)	CP6/CP7	Gauge	CP7, CP8
MML South speed improvements (for Heavy Axle Weight traffic) (including at Sharnbrook Viaduct near Bedford)	CP6/CP7	Capability	CP7, CP8, CP9, CP11+
Corby speed improvements (for Heavy Axle Weight traffic) (including at Harringworth Viaduct)	CP6/CP7	Capability	CP7, CP11+
Sheffield speed improvements (for Heavy Axle Weight traffic) (including at Attercliffe Viaduct)	CP6/CP7	Capability	CP7
MML South speed improvements (from less than 60mph) (including Bedford to Harrowden Jn)	CP6/CP7	Capability	CP9, CP11+
MML South speed (from 60mph or above) (including St Albans area)	CP6/CP7	Capability	CP7
MML North speed improvements (from less than 60mph) (including Leicester area)	CP6/CP7	Capability	CP7, CP9, CP10
MML North speed improvements (from 60mph or above) (including Sileby to Loughborough)	CP6/CP7	Capability	CP9
Capacity enhancements in the area south of Bedford area including grade separation at Harpenden and Leagrave Junctions.	CP8 & beyond	Capacity	CP7
Enhancements in the Bedford area including a new platform and new turnback south of the station. Medium term.	CP8 & beyond	Capacity	CP7
Kettering – Wigston North Junction enhancements: 4-tracking Kettering North Junction to Kilby Bridge Junction.	CP8 & beyond	Capacity	CP9, CP11+
A new line linking Stenson Junction to the MML at Trent Junctions, north of East Midlands Parkway station.	CP8 & beyond	Capacity	CP7, CP10
Increased line speed between Stenson Junction (near Derby) and Sheet Stores Junction (near Derby).	CP8 & beyond	Capacity	CP7
Additional turnback facility at Derby station.	CP8 & beyond	Capacity	CP7
Further capacity at Peak Forest, including remodelling of layout by Dowlow and Hindlow Quarries and extension of Buxton Up Relief Sidings. To facilitate trailing weight increase from 1,750 tonnes – 2,600 tonnes at Dowlow and Hindow quarries. Medium term.	CP8 & beyond	Capacity	CP10
Improve access to aggregates terminals including Mountsorrel.	CP8 & beyond	Capacity	CP9
Improvements to capacity between Dore to Sheffield, including reinstating four tracks and loss of sidings in Sheffield station, and doubling at Dore. Medium term.	CP8 & beyond	Capacity	CP7
Reopening of Matlock-Buxton rail link.	CP8 & beyond	Capacity	N/A
Aspiration: to increase length of construction trains, but improvements to traction issues will also need to be investigated	CP8 & beyond	Capability	CP7, CP8, CP11+

Corridor 10. Great Western Main Line - Coloured lines represent ETCS deployment by Control Period

1	Remodelling of Bishton Flyover (with flat junction) and west end of Severn Tunnel Jn	7	Electrification of Avonmouth Branch
2	Remodelling of Bishton Flyover (with replacement flyover) and east end of Severn Tunnel Jn	8	Gauge clearance infill to W12 between London, Bristol and Cardiff
3	Grade separation at Maindee West Jn	9	Gauge clearance to W12 from Severn Tunnel Jn to Cardiff
4	Headway improvements between Bishton and Maindee Jn	A	Grade Separation at Didcot East and Oxford North Jns and capacity improvements at Oxford Station
5	Headway improvement on main lines between Ebbw Jn and Cardiff Central	B	Grade separation at Didcot East Jn, capacity improvements Didcot-Oxford and Oxford Station
6	Headway improvement on main and relief lines between Ebbw jn and Cardiff Central		

Scheme	SFN Priority	Type	ETCS Deployment
Gauge clearance infill to W12 between London, Bristol and Cardiff (including Chipping Sodbury Tunnel and Newport Old Tunnel)	CP6/CP7	Gauge	CP8 TO CP11+
Gauge clearance to W12 from Cardiff to Severn Tunnel Jn	CP6/CP7	Gauge	CP10
Aspiration: to remove sections of low line speed, to enable freight to achieve greater average speed	CP6/CP7	Capability	N/A
Acton speed improvements (at Acton junctions)	CP6/CP7	Capability	CP8
Either: Remodelling of Bishton Flyover (with a flat junction) and the west end of Severn Tunnel Junction. Or: Remodelling of Bishton Flyover (with a replacement flyover) and east end of Severn Tunnel Junction.	CP8 & beyond	Capacity	CP10
Grade separation at Maindee West Junction (near Newport).	CP8 & beyond	Capacity	CP10
Headway improvements between Bishton and Maindee Junction (near Newport).	CP8 & beyond	Capacity	CP10
Either: Headway improvement on the main lines between Ebbw Junction and Cardiff Central. Or: Headway improvement on the main and relief lines between Ebbw Junction and Cardiff Central.	CP8 & beyond	Capacity	CP10, CP11+
Electrification of the Avonmouth branch near Bristol. Medium term.	CP8 & beyond	Capacity	CP10
Aspiration: to increase in freight average speed from 45mph to 60mph, either through enhancing or replacing existing wagons and, ultimately 75mph to yield significant capacity benefits. The potential options for this include: i) Enhancements to/new wagons; ii) Electric traction (and therefore electrification) to achieve 75mph	CP8 & beyond	Capability	N/A
Aspiration: to increase length of construction trains, but improvements to traction issues will also be required to be investigated	CP8 & beyond	Capability	N/A

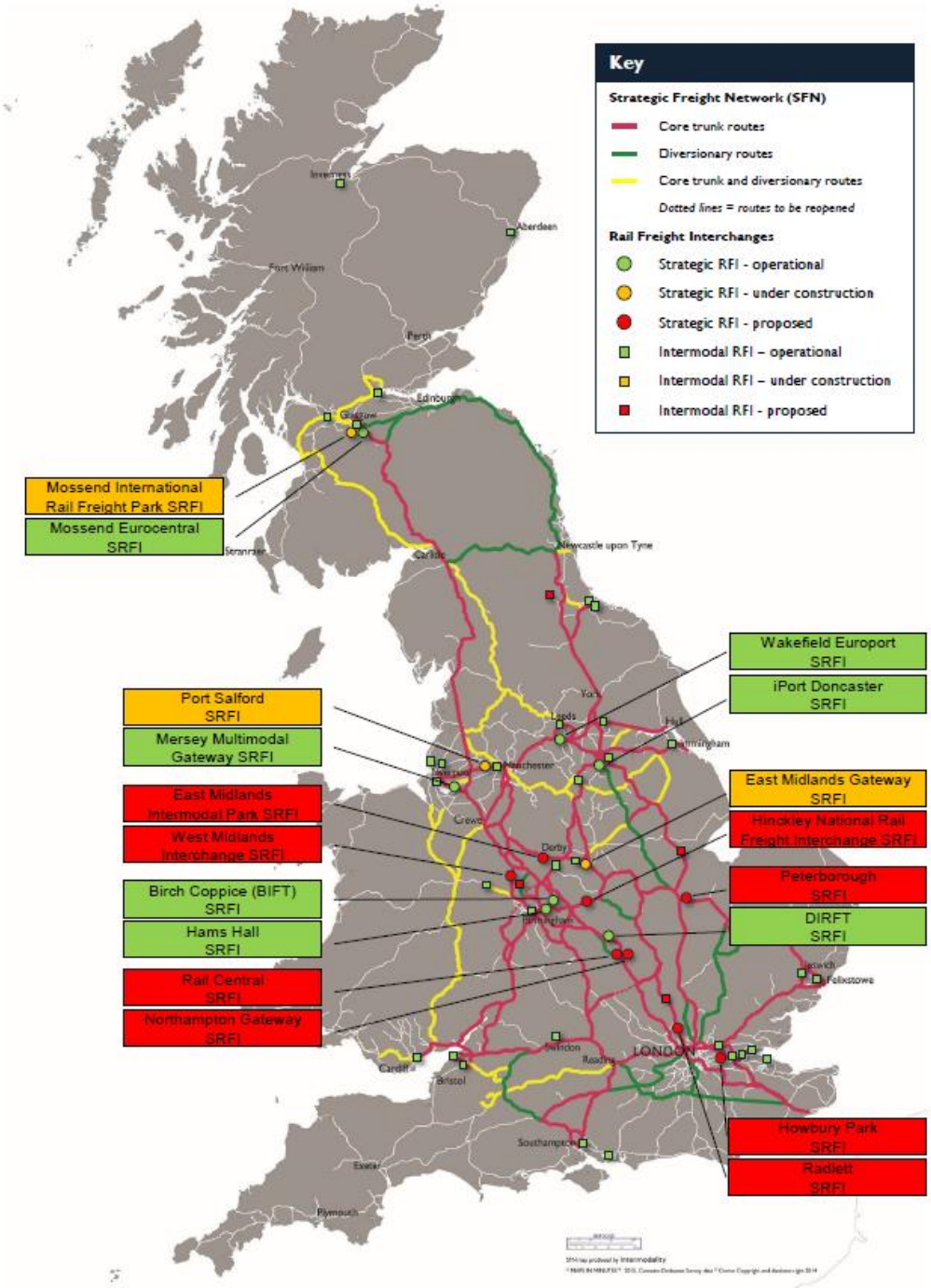
Corridor 11. Anglo-Scottish & Northern regional traffic - Coloured lines represent ETCS deployment by Control Period



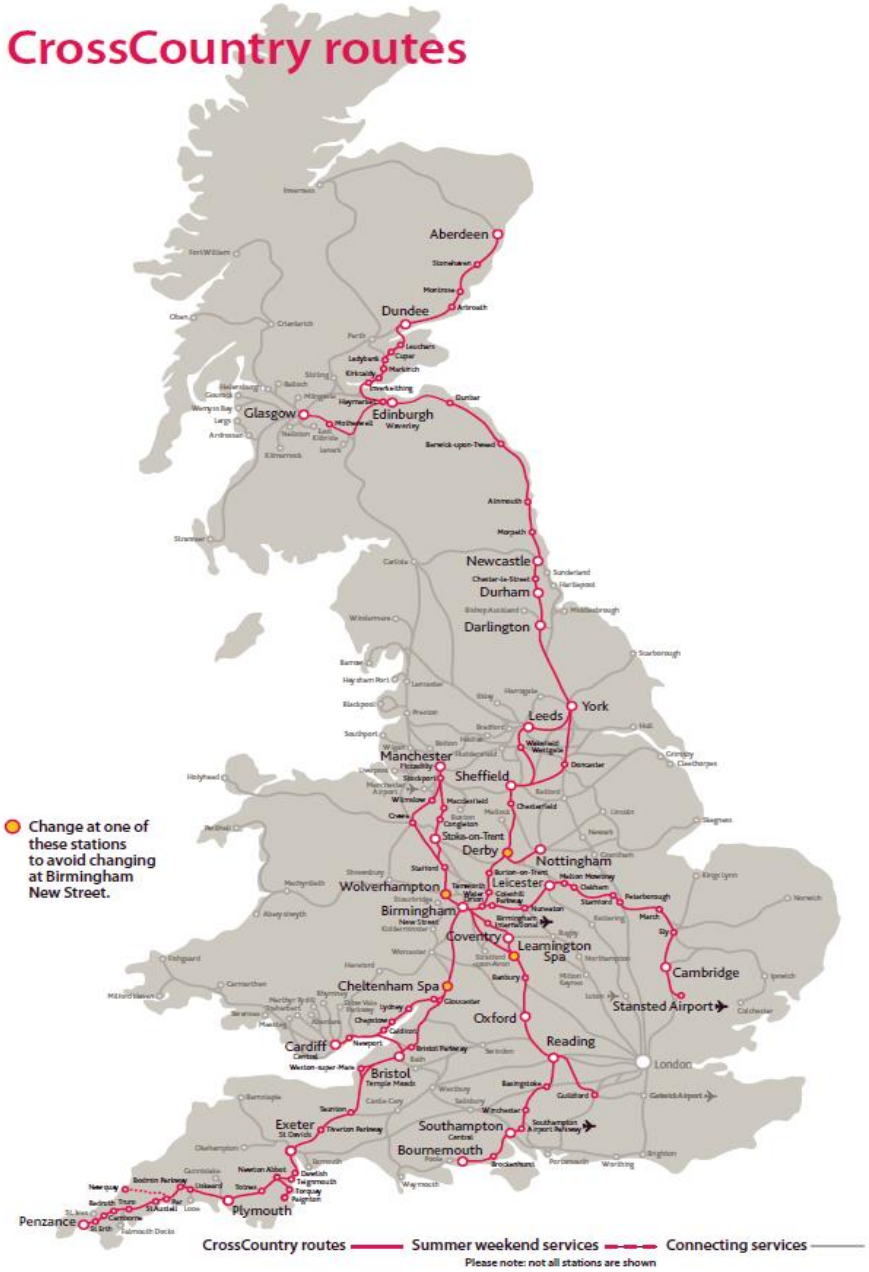
1	Grantshouse dynamic loops and 4-tracking Prestonpans to Drem	7	Looping strategy between Dundee and Aberdeen
2	Edinburgh suburban line capacity improvements	A	Carlisle Station remodelling: incl. 4-tracking both approaches
3	Enhancements to loops north of Newcastle	B	3 or 4-track Gretna Jn to Floriston
4	Capacity interventions on ECML between York & Newcastle	C	4-tracking sections from Carlisle to Carstairs
5	4-tracking in Hare Park Jn area	D	Carstairs remodelling
6	Freight loop at Camperdown	E	South Yorkshire Joint Line gauge clearance
		F	Electrification of Yorkshire freight route

Scheme	SFN Priority	Type	ETCS Deployment
Dynamic loops on ECML at Grantshouse (near Berwick-upon-Tweed) and four-tracking ECML Prestonpans to Drem (east of Edinburgh)	CP6/CP7	Capacity	CP7
Edinburgh Suburban Line capacity improvements, including: remodelling of Portobello, Slateford and Niddrie West single lead junctions, upgrade of the signalling capacity, enhancement of the Millerhill through route capabilities (from Monktonhall Junction) in addition to electrification.	CP6/CP7	Capacity	CP10
4-tracking existing 2-track railway in the Hare Park Junction area, south of Leeds	CP6/CP7	Capacity	CP8
Freight loop at Camperdown (North of Dundee).	CP6/CP7	Capacity	CP8
Looping strategy for freight between Dundee and Aberdeen.	CP6/CP7	Capacity	CP8, CP10
Aspiration: W12 strategic infill of sections connecting to East Coast Main Line	CP6/CP7	Gauge	CP7, CP9, CP11+
Aspiration: Remove sections of low line speed to enable freight to achieve greater average speed	CP6/CP7	Capability	N/A
East Coast North speed improvements (for Heavy Axle Weight traffic) (including through Morpeth Station)	CP6/CP7	Capability	CP7
Enhancements (length and speed) to existing loops north of Newcastle.	CP8 & beyond	Capacity	CP7, CP9
Interventions on the ECML between York and Newcastle to manage the speed mix and accommodate freight and passenger traffic. Options include realigning tracks north of York, remodelling Northallerton station, and potential new alignments to provide diversionary route to ECML. Medium term.	CP8 & beyond	Capacity	CP7, CP9, CP11+
Aspiration: to increase in freight average speed from 60mph to 75mph on ECML to help reduce end to end journey time. A further aspiration is to increase average speed in conjunction with loops, in line with East Coast Connectivity. This could have substantial benefits to terms of capacity and resilience.	CP8 & beyond	Capability	N/A

F.03 Appendix 3. Strategic Rail Freight Interchanges



F.04 Appendix 4. CrossCountry Trains Route Map



F.05 Appendix 5. Caledonian Sleeper Route Map