

Digital Railway Programme Strategic Plan

19 January 2018 – RF9 update

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1. Purpose, role & vision

1.1. Digital Railway Programme Purpose

The Digital Railway Programme is a benefit driven, cross-industry change programme enabled by technology, which will facilitate the delivery of systems, technology, business and people change in an integrated way.

Digital technologies are integrative as they require greater levels of integration across track and train operations and also between real time control systems and the IT business systems. Digital signalling systems are deployed on rolling stock as well as on fixed infrastructure and operating centres linked to timetable planning systems, triggering the need for a new way of working not currently experienced by UK railways. This merges railway systems and, through telecoms and data, the real time IT systems.

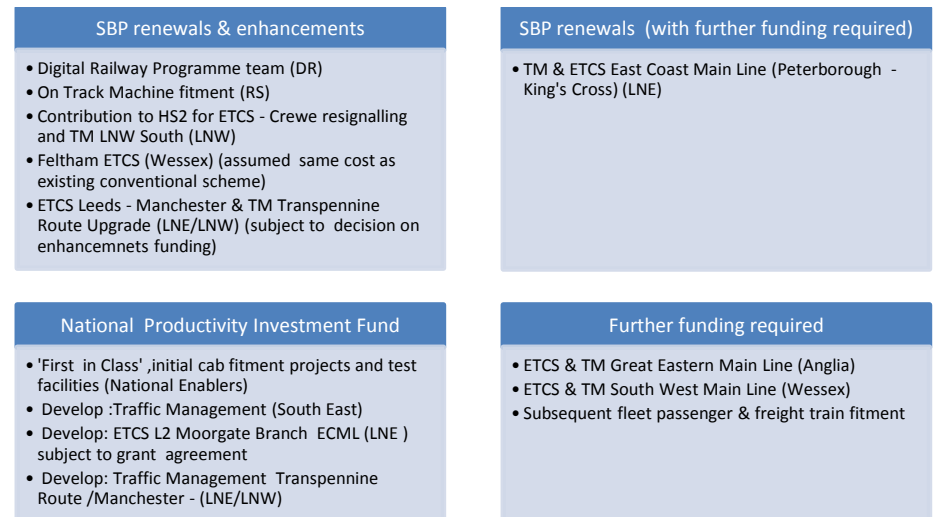
The Digital Railway Programme is a pan industry programme leading the **transformation of the railway** through digital train control and signalling. Good progress is being made fitting trains with European Train Control System (ETCS) in-cab equipment. However, developing new ways of working with the supply chain and an alternative procurement model are fundamental to transforming the network in an affordable way. This challenging shift is focused on moving from geographically-specific signalling renewals, to an integrated package of interventions in partnership with franchises and joint working with suppliers to achieve required outcomes based on whole of life costs.

In CP5 **funding has been agreed from the National Productivity Improvement Fund** for development. Subject to business case, it is assumed this will fund the delivery in CP6 of South East Traffic Management and

Connected Driver Advisory Systems (TM and C-DAS), bringing closer track-train integration to improve performance. This fund is also expected to enable rollout of ETCS on infrastructure needing replacement at Moorgate aligned with planned train fitment on a new fleet. There is a wider pipeline of schemes under consideration.

This Strategic Business Plan sets out the Digital Railway Programme's plans for Control Period 6. Significant progress has been made to integrate with the conventional plans put forward by the Routes. The initial digital schemes that are being developed and the current funding position, is summarised in Figure 1. We are exploring alternative funding and financing options, where appropriate, and aim to have developed proposals by the end of 2018.

Figure 1: Digital funding pipeline and the Strategic Business Plan (SBP)



1.2. Digital Railway Programme Role

Within a complex industry, the efficient and effective deployment of these new integrative technologies and ways of working requires a co-ordinated approach to optimise benefits and improve cost efficiency. In this context, the core role of the Digital Railway Programme is to provide systems leadership, industry sponsorship, industry change strategies, and business and systems requirements for Network Rail's Route Businesses and wider industry to procure and implement the Digital Railway.

The Digital Railway Programme is an industry-wide **programme to develop, specify, sponsor and support the roll-out of digital signalling and train control**, to best effect, in meeting the needs of the passengers, freight customers, funders and benefits for the wider economy.

The Digital Railway Programme provides:

- **Systems leadership and industry support** through an enterprise architecture and national systems authority for digital train control and signalling;
- **Industry sponsorship** to ensure business cases for

deployment of digital train control systems are identified, funded, prioritised and deliver whole life benefits;

- Industry change strategies to ensure that an **industry operating model** is in place to optimise the use and extract the full benefits of new technology; and
- Advice and support to Routes, train companies, government and other stakeholders, as well as **growing industry capabilities** in digital railway skills.

1.3. Digital Railway Programme Vision

The vision for the Digital Railway Programme is “A Digital Railway for a Modern Britain”.

The Digital Railway is following this vision to realise targeted capacity, performance and safety benefits from full Automatic Train Protection (ATP) and track worker safety. Through the proposed packaging of line of route-wide upgrades, including conventional and digital interventions, the Digital Railway Programme has a significant role to play in enabling the delivery of benefits to passengers and freight users, broader society and the rail industry itself. Benefits of the technology evidenced in business case analysis are shown in the table overleaf.

Table 1: Digital Railway programme benefits summary

		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
People	Industry skills, capability and business change	Enabled by people, skills, capability and business change						
Technology	Safe separation of trains - ETCS (European Train Control System)	✓	✓	✓	✓	✓	✓	
	Traffic Management	✓		✓		✓		✓
	Train Movement Control - Connected Driver Advisory System (C-DAS) & Automatic Train Operation (ATO)	✓	✓	✓	✓			
	Track Worker Safety Systems: Traffic Management Protection and Signaller Controlled Warning Systems (SCWS).	✓		✓	✓	✓	✓	
	Telecoms and Data	Enabled by telecoms and data						

Network Rail is committed to delivering the digital railway vision and all relevant CP6 plans present this. The Digital Railway Programme is reviewing the conventional signalling workbank (particularly partial and targeted renewals) for signalling to demonstrate that the conventional renewals align to a digital future. Results of the workbank review and emerging processes for future digital migration will be shared with ORR in the coming months.

Over 63% of ageing signalling equipment must be renewed over the next 15 years, a challenge that can only be delivered affordably by cheaper whole life solutions, which the digital railway is aiming to facilitate. The Rail

Delivery Group and Rail Supply Group have jointly proposed to government in October 2017 that digital train control and traffic management systems can be rolled out at lower cost than conventional signalling by 2025 as part of a 'sector deal'.

For clarity, Section 5 of this Strategic Plan for the Digital Railway Programme sets out the consolidated programme expenditure across all Network Rail's business functions and Routes that will contribute to the deployments aspired to in CP6/7. It also sets out passenger and freight train operator train fleet deployment costs.

Section 6 identifies expenditure and efficiency data specific to the Digital Railway Programme function.

2. Objectives & Stakeholder priorities

Control Period 6 is expected to mark a turning point for digital deployment, as increasing amounts of digital railway-ready infrastructure and ETCS fitted trains (Figure 2) are rolled out, together with digital train control, traffic management and connected driver advisory systems. As more trains are fitted with ETCS (ATP), this will strengthen the ALARP argument to switch from conventional coloured light signalling. The integrative effect of digital technologies and the investment of multiple parties (franchised and open access train operators, Department for Transport and Network Rail) mean stakeholder priorities are central to the delivery of the Digital Railway.

2.1. Stakeholders & priorities

The Digital Railway Programme’s priorities and target routes for deploying digital technologies arise from the rail industry’s Long Term Planning Process and its Route Studies in particular, reflecting the extensive stakeholder engagement which took place to form these documents.

In addition, specifically with route devolution in mind, extensive additional consultation has taken place to form key inputs (see Route Steering Boards in ‘Engagement activities’ section below).

Figure 2: Committed digital investment in passenger trains

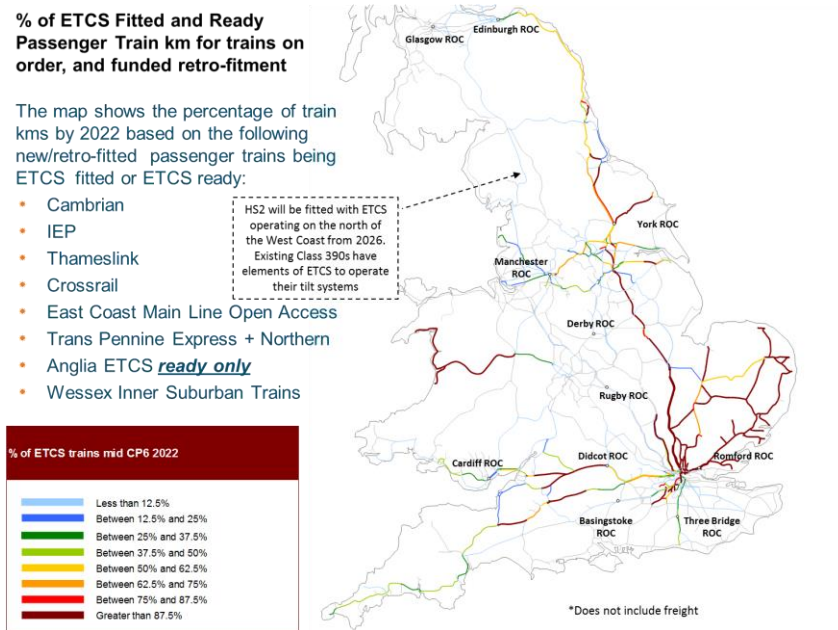
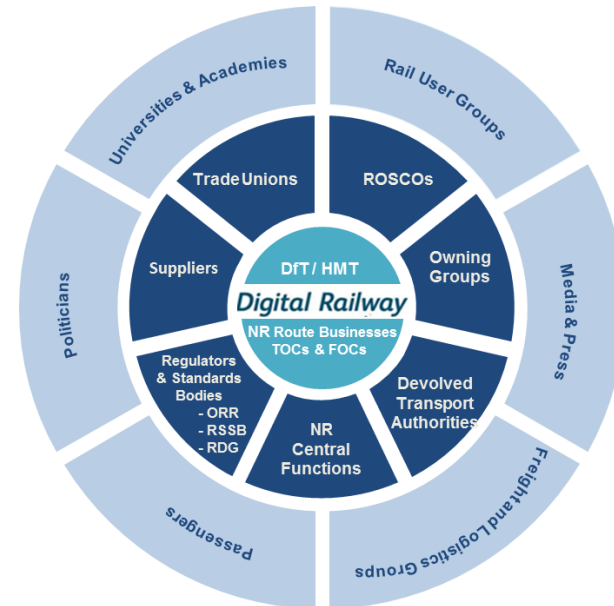


Figure 3: Participants and stakeholders in the Digital Railway programme



Key stakeholder groups for the digital railway are illustrated in Figure 3. Their priorities for Network Rail and the programme are:

- Government and Regions^{1, 2}
 - Maintained focus on safety
 - Better journeys for passengers and freight
 - Value for money to the tax payer and fare payer
 - Reasonable, affordable and deliverable operations, maintenance and renewal of the rail network
 - Increased inclusive economic growth
- Office of Rail and Road³ (ORR)
 - A safer railway
 - Better customer service
 - Improved efficiency and value for money for taxpayers, fare payers and funders
 - A dynamic and commercially sustainable rail sector
- Route Businesses (Network Rail):⁴
 - Improved long term train performance
 - Increased capacity to meet current and future demand growth
 - Capitalising on opportunities to reduce cost and disruption to Routes and their customers through alignment with franchise, rolling stock and asset renewals
 - A safer railway for users, workers, neighbours and the public
- Rail Delivery Group (RDG), Operators and Owing Groups⁵
 - Quality and equality of service
 - Efficient costs
 - Stable, consistent and nationally co-ordinated rollout of

¹ Railways Act 2005 Statement High Level Output Specification (DfT) 20 July 2017

² The Scottish Ministers' High Level Output Specification for Control Period 6 (Transport Scotland) 20 July 2017

³ Business Plan 2017-18 (ORR) 6 April 2017

⁴ Routes' SOBC problem and opportunity statements (NR) April 2017

⁵ Memorandum of Understanding (RDG and NR) 15 November 2016

- digital technologies
- Promotion of alignment of incentives
- Open and transparent decision making with industry partners before implementation
- Supply Chain⁶
 - Clarity and stability of outcomes/timescales to create the market conditions for growth
 - Accelerate the uptake of innovation
 - Investing in people and skills in order to address future skills shortages and to increase productivity
 - Grow exports and inward investment to unlock new opportunities at home and overseas and grow UK manufacturing
- System Operator
 - Effective integration of digital railway solutions in the industry Long Term Planning Process, to support proactive consideration of technology as an option to enhance capacity and to inform decision making by funders
 - Holistic engagement of the digital railway programme in the franchise competition process, to enable better alignment and better outcomes for funders, operators and passengers
 - Supporting the Digital Railway Programme through investment in timetabling tools and technology to enable the realisation of digital railway capacity benefits in the timetable
- Safety, Technical and Engineering (STE)
 - Current priority is Digital Railway Programme input to the Rail Technical Strategy on industry readiness levels and delivery of agreed capability levels for control, command and signalling assets.

⁶ Fast Track to the Future – A strategy for productivity and growth in the UK rail supply chain (Rail Supply Group) February 2016

- Network Rail is considering whether for CP6 further specification activity will continue to sit with the Digital Railway Programme or with STE.

Digital railway rollout will contribute to delivering most of these stakeholders' priorities. However, as further business cases are developed, discussions will need to continue on how best to meet Network Rail's train operator customers' and supply chain's desire for a clear and stable rollout plan.

Engagement activities

Industry stakeholders including RDG, freight operators, Rolling Stock Companies, ORR, RSSB, Transport Scotland and DfT are represented on Digital Railway's governance forums i.e. Programme Board (the key Digital Railway Programme (DRP) decision making body) and the functional boards below: Deployment Board, Strategy & Business Case Board and Systems & Operations Board, reflecting that DRP is an industry programme.

Route Steering Boards (RSBs) were established for strategic decision making in each of the five Routes where a digital upgrade was being considered for CP6, to bring together a range of stakeholders, including train operators, the Department for Transport and senior planners to review technical outputs of the Digital Railway Programme. More RSBs are being established as the demand to look at digital railway deployments increases.

RSB membership generally includes:

- Route Managing Directors, Network Rail;
- Route Asset System & Integration Managers, Network Rail;
- Directors of Route Asset Management, Network Rail;
- Strategic Planners, Network Rail;
- Department for Transport;
- Passenger and freight train operating company (TOC and FOC) representatives;

- Rail Delivery Group;
- Digital Railway Technical Specialists.

The five RSBs have endorsed the process, options and assumptions for Strategic Outline Business Cases (SOBCS), the final documents have been reviewed and shared with DfT, which has recognised and accepted the findings. The DfT used the main findings of the SOBCs to inform their development of their SOBC seeking funding from the National Productivity Improvement Fund (NPIF) – further details of which are described in section 3 below.

A wide range of current and potential suppliers have been engaged through monthly meetings of system integrators, technology providers, non-traditional rail suppliers and other specialists. Many suppliers have also contributed to Early Contractor Involvement workstreams (see section 5.3).

The Digital Railway Programme has had positive engagement with the Trades Unions. In October 2016 a Joint Working Group was established for Network Rail operations that includes Network Rail Routes and the central team, as well as the Transport Salaried Staffs' Association (TSSA) and the National Union of Rail, Maritime and Transport Workers (RMT). In December 2016 a similar strategy for Network Rail Maintenance with RMT, TSSA and Unite was agreed with the National Maintenance Council. Rail Delivery Group lead on Digital Railway briefings to the Trades Unions recognised by TOCs and FOCs. Personal updates to Union Executive Groups have also been delivered by Digital Railway.

These discussions have included all of the products, training and possible changes to working for people working with these new tools. The DR programme is now focused on upskilling the key representatives on the technology and seeking to gain a letter of agreement on this industrial relations strategy with all the key union leaders.

2.2. Specific objectives

The Digital Railway Programme is an essential thread running through Network Rail's plans for CP6, contributing directly to all of the aspects of the corporate strategy which is:- 'To increase capacity and improve safety, reliability and value for customers and taxpayers, we have to work more closely with train and freight companies and unlock the potential of our workforce and by investing in our people we aim to attract the best talent.'

The programme objectives contribute to delivery of the following corporate objectives:

- Secure industry-wide buy-in to DR and funding from DfT to deliver targeted DR solutions in CP6;
- Introduce technology to support ways of planning and delivering safe work;
- Reduction of workforce fatalities and major injuries to zero;
- Reduce delay per incident by 30% by the end of CP5;
- Deliver renewals unit rates and volumes in line with plans for CP5 and beyond.

As a result of stakeholder input, the following key objectives have been developed for the Digital Railway Programme:

Integrating into Routes' and central functions' Strategic Business Plans to address asset sustainability by revolutionising Network Rail's supply chain relationship - re-signalling projects are some of the most challenging to deliver against expanding passenger and freight usage and recent renewal schemes' costs have exceeded estimates. The Digital Railway Programme aims to reduce whole life costs of command, control and signalling by up to

30% by embracing disruptive innovation in the design and development of train control and traffic management systems. Delivering a digital railway will also reduce the scale of disruption to train services of major civil engineering interventions.

- **Targeting deployment of digital train control to address current and future capacity, journey time and performance issues** - passenger numbers have more than doubled in the last 20 years and there are now 1.69 billion passenger journeys p.a. Train punctuality is not where we want it to be and 70% of delays are now from knock-on effects rather than a primary cause. Digital train control will be deployed on the basis of the best value investment, addressing capacity, journey time and performance challenges identified by business cases.
- **Aligning to Route plans for consolidation of 'areas of control' for operational efficiencies** – each Route has its own migration plans to consolidate their train control systems within centralised locations (e.g. ROCs), this consolidation will be supported by Traffic Management.
- **Aligning with and influencing of franchising to optimise industry cost, performance and capacity** – taking opportunities to partner with franchisees to deliver operational efficiencies, improved train services and less disruption in future.
- **Continuous safety improvement** - current safety systems work well but cannot provide automatic train protection capabilities for all trains in all circumstances. Deployment of digital traffic management and train control systems will improve train protection in a wider range of circumstances than current systems can deliver.

The Digital Railway Programme has welcomed the

Government's development of an industrial strategy⁷. We have set out how the programme aligns with and contributes to the industrial strategy to support the Government's ambitions of improving living standards and economic growth. This will be achieved by utilising modern digital techniques and solutions to:

- enable performance improvements in the rail network's operations, maintenance and management as new technologies (such as intelligent infrastructure monitoring) become more responsive and adaptable
- transform rail industry operating models to improve capacity and availability of the GB rail network
- maximise the use of automation in operations and project delivery
- improve productivity in the delivery of telecommunications, train control and traffic management projects
- enable development of specific digital railway skills and capabilities across industry
- use and promote new and more holistic approaches to procurement of goods and services to enable an effective, timely and value for money realisation of DR's objectives whilst optimising the benefits for the wider economy
- provide a robust and practical platform for UK companies to develop opportunities in overseas markets around the application of digital railway products, services and knowledge

Network Rail's strategy for telecommunications is integral to the Digital Railway Programme in providing current and near term enabling connectivity, as well as developing a

network and service platform for future control, command and signalling applications.

Table 2, overleaf, sets out the programme's more detailed objectives for the short, medium and long term to address current and future capacity, performance, safety and financial sustainability issues.

DRP is part of the wider GDR function and for 2017/18, it contributes to GDR scorecard (see Table 3 overleaf) measures of:

- GDR milestone delivery;
- Cash compliance; and
- Safety.

Once funding is committed to develop SOBC schemes, further measures will be developed for CP6. Using the learning gained during the development of the SOBCs and the successful application of the RSB methodology, additional RSBs are being set up and existing RSBs continued.

⁷ Building our Industrial Strategy (Department for Business Energy and Industrial Strategy) 23 January 2017

Table 2: Digital Railway programme objectives

Benefits enabled	Increased capacity	Safer, more secure & environmental railway	Improved train performance (reliability and availability)	Improved whole life cost and sustainable commercial model	Wider socio-economic (e.g. skills, productivity, housing, exports)
Long term objectives – Wider Scale Deployment*	Provide the digital capability for a whole system capacity uplift to meet projected demand on the railway.	One system architecture for signalling and train control system for GB.	Improved performance (availability and reliability) through digital train control and signalling, to enable a better customer experience.	Set of financial and delivery options and their associated WLC and benefits to facilitate digital transformation and improve affordability of GB railway.	<ul style="list-style-type: none"> • Job creation and multiplier benefits • Productivity benefits through reduced delays • Increased use of freight rail with economic benefits for UK Plc • GB hub for train control and signalling expertise and innovation, with export opportunities • Enhanced ability to support housing plans.
Medium term objectives – Targeted Deployment	Demonstrate targeted digital train control and signalling solutions as part of a whole system upgrade that meets projected demand.	Co-ordinate and integrate partners, their learning and the developed standardised configurable system which is deployed on the railway on a targeted route basis.	Demonstrate the performance, availability and reliability benefits of digital train control and signalling on targeted schemes to enable a better customer experience.	Working with partners investigate, explore and develop commercial models for a targeted route basis while reducing WLC.	
Short-term objectives – Initiation	Secure funding and undertake initial development of targeted digital train control and signalling schemes for CP6 deployment.	Assured requirements for a standardised configurable system (process, organisation, technology, information) ready to be deployed.	Support the delivery of current CP5 programmes that demonstrate the capability of DR solutions.	Co-ordinate and integrate partners and their learning to exploit and deliver the commercial models on a route basis.	

Table 3: Group Digital Railway scorecard

Group Digital Railway scorecard												
CP5 (FY18 & FY19)							CP6					CP7
Category	Measure	Weighting	Included Measure	Minimum Performance Level	Target Performance Level	Maximum Performance Level	Target Performance Level	Target Performance Level	Target Performance Level	Target Performance Level	Target Performance Level	Target Performance Level
Safety	Work Related Absence	15%	5%	29	24	19	24					24
	Close calls % closed within 90 days		5%	80%	85%	90%	85%					85%
	7 Milestones to reduce information security risk, improve safety culture and employee wellbeing.		5%	5	6	7	6					6
Financial Performance	Financial Performance Measure (FPM) - excl. enhancements (£m)	15%	10%	(£4.74m)	£0	£4.74m	£0					£0
	17/18 Cash Compliance		5%	(£1.58m)	£0	£6.32m	£0					£0
Investment	Top Investment Milestones	25%	15%	30	32	34	TBC					TBC
	Capability Delivered		10%	£13.1m	£26.2m	£41.6m	TBC					TBC
Asset Management	Reduction in Telecoms Service affecting failures	15%	5%	3,120	2,836	2,552	2,694	2,559	2,432	2,310	2,194	2,085
	Telecoms Renewals Volumes		5%	5,883	6,537	7,191	TBC					TBC
	Data Collection Services		5%	92%	95%	97%	96%					97%
Train Performance	Reduction in Train delay minutes	10%	5%	127,271	115,701	104,131	109,916	104,420	99,199	94,239	89,527	85,051
	FTNx reach		5%	80%	90%	100%	TBC					TBC
Locally Driven Customer Measures		20%	20%	86%	90%	93%	92%					94%

3. What Digital Railway Programme is

3.1. Structure

The Digital Railway Programme reports via the Managing Director, Group Digital Railway to Network Rail’s Chief Executive and works closely with the devolved Routes, the System Operator and the Safety, Technical and Engineering functions in Network Rail.

The programme is being structured on the basis of providing expertise and coordination to an empowered and outcome-focused digital railway supply chain.

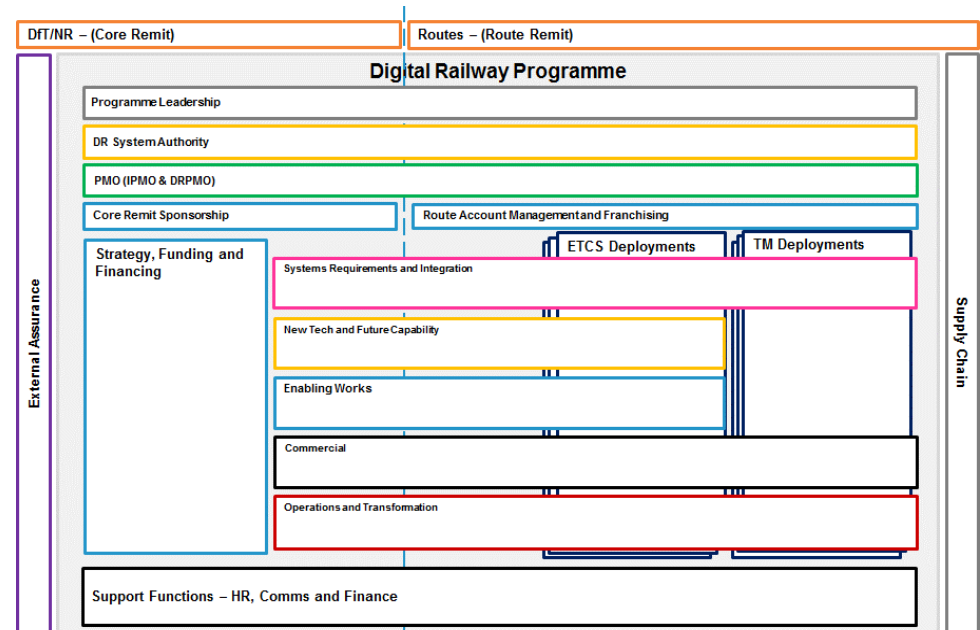
The programme is operating three central elements:

- A. **Strategy and Business Case Development** – analysing the issues that the railway currently faces, what capabilities Digital Railway could deploy to remedy the issues, and developing business cases to justify the cost of change; all in conjunction with the Routes and broader industry;
- B. **Programme Management Office** – managing the plan, risks, interdependencies and national interfaces at an enterprise level. Monitor benefit realisation across multiple locations;
- C. **Rail System Authority** - ensuring that the technologies and configurations developed are compatible, safe and of a standard that will generate benefits.

The programme will support and co-ordinate deployments for Routes and their customer TOCs and FOCs, acting as expert adviser and retainer of key GB digital railway capabilities, acquired through early (CP5) deployments. The central programme elements are themselves supported by a number of other programme functions, as shown in Figure 4 opposite.

Section 6 below sets out indicative core costs for this team.

Figure 4: Digital Railway Programme structure



3.1.1 Strategy and business case development

The programme has developed five SOBCs (with certain Routes and other stakeholders) for digital upgrade schemes. These SOBCs represent an early stage of the investment decision framework (HMT’s ‘Green Book’) as required in the memorandum of understanding agreed between Network Rail and the DfT signed on 23rd March 2016.

These SOBCs, submitted to the DfT by the DRP, are upgrades on Routes which are now integrated (along with related enabling projects) into the Strategic Plan of each Route and central function affected. These costs will be subject to further evaluation and development if the SOBC schemes are taken forward to Outline Business Case (OBC). The exception to this approach is in Western Route, where follow up activities to the SOBC have been taken forward as a supplier collaboration to pilot a traffic management system at Didcot and Thames Valley Signalling Control Centre ('Didcot').

These activities will provide additional information for funders to inform their decision on whether to take forward design of the preferred ways forward.

In reflection of further demand for digital railway technologies, other parts of the network where additional

digital upgrade business cases are being developed or considered include; the Manchester area (North of England Programme NoEP), Feltham area in Wessex, Crewe Hub with HS2/DfT, East West Rail, Merseyrail and work in association with Crossrail 2. At this stage, no costs are included in Network Rail's Strategic Business Plan for any of these potential digital upgrade schemes. As these schemes' business cases are developed, Network Rail will continue to discuss with DfT how best to take them forward.

The desired outcomes and resulting ETCS and TM interventions for deployment in CP5, 6 and 7, based on the first SOBCs are described in Table 4 below and in further detail in each relevant Route's Strategic Plan.

Table 4: Preferred way forward for first Route SOBCs

Route	Desired outcomes	ETCS interventions	TM interventions
Anglia	<ul style="list-style-type: none"> ➤ Peak 27 tph GEML service ➤ Up to -6% reactionary delay ➤ Capacity for Norwich in 90, Ipswich in 60 	ETCS L2 on GEML (no signals Chelmsford-Stratford) at point of renewal & combined with other schemes e.g. ECML (S) to share costs (CP6/7)	CP6 deployment: TM on GEML, WAML, NLL appears high VfM, independent of ETCS
LNE & EM	<ul style="list-style-type: none"> ➤ +2-4 tph on Moorgate branch ➤ 8 LDHS services ➤ Supports TLK output, mitigates 1-2% PPM reduction ➤ Up to -5% reactionary delay ➤ Reduce journey times 	CP6 deployment: ETCS L2 (no signals KX- Peterborough) indicates VfM & also bears its fixed costs, but very dependent on PPM performance benefit assumed & on alignment with renewals	Extending TM to Peterborough: VfM likely to be improved with reduced geography, further analysis needed
South East	<ul style="list-style-type: none"> ➤ Up to -7% reactionary delay mins (short-term) ➤ Long term capacity improvement (post TLK) 	ETCS ready infrastructure adds costs but does not provide immediate benefits – Croydon Remodelling required first	CP6 deployment: Route-wide TM benefit delta over TLK appears high VfM

	programme & BML upgrade)		
Wessex	<ul style="list-style-type: none"> ➤ Peak 30 tph Woking-Waterloo ➤ Better regulating decisions to improve performance ➤ Reduce journey times / increase service frequency 	ETCS options on SWML (no signals Woking-London Waterloo) at point of renewal (CP8) but if XR2 goes ahead this may strengthen a case for earlier delivery (options to install digital railway on suburban trains / routes being explored)	CP6 deployment: Route-wide TM appears high VfM, independent of ETCS

In addition, in the Autumn Statement 2016, a new National Productivity Improvement Fund (NPIF) was announced to be targeted at four areas including transport, within which an allocation was made for £450m proposed for testing signalling technology. The indicative spend profile for the NPIF is targeted as follows:

National Productivity Improvement Fund Spend Profile in 2016-17 Cash Prices				
Year	2018-19	2019-20	2020-21	2021-22
Spend (£ million)	50*	150*	250*	*

** Note the spend profile set out by the DfT above are caps in each year, with an expectation that some underspending between 2018-19 and 2020-21 will be pushed back to 2021-22, up to a limit of £190m.*

A list of candidate schemes enabling or providing for early deployment of digital railway technology has been developed by the Digital Railway Programme and the DfT which is shown in Table 5, overleaf. Some of these schemes overlap with DRP's Route SOBC proposals and other enabling activity for wider system implementation.

Table 5: NPIF candidate schemes and enabling activities submitted to BICC

Name of scheme	Approved funding	Brief description of the funded activity	Benefits enabled and primary outcomes	Total anticipated cost estimates (if approved for delivery) Rough Order of Magnitude Cost (if not approved for delivery)
First in Class fitment and testing	£85m	Deliver selected First in Class fitment and test facilities at RIDC and ENIF.	Enablers for schemes below	£85m (already approved)
TM on South East & East London Line <i>NB This excludes the franchise area covered by separate scheme below.</i>	£5m	Develop OBC for TM on South East (excluding franchise area) & adjoining section of East London Line routes. OBC due for completion November 2018.	5 – 10% reduction in delay minutes Performance and safety	£145-270m
DR options between Manchester and York including Transpennine	£5m	Explore then develop DR options between Manchester and York including on the Transpennine Route. Interim reports due in December 2017 and January 2018 on DR options for TRU and on the Castlefield Corridor.	Capacity, performance and journey time improvements	£100-200m (to be confirmed)
ETCS on Moorgate Branch	£5m	Develop ETCS 'signals away' renewal scheme on the Moorgate Branch of East Coast Mainline. Grant agreement still to be finalised between DfT and NR.	+2 – 4 tph Capacity, performance, safety & asset renewal	£30-50m
TM in Southeastern Franchise	£75m	New franchisee to develop, design and deliver TM scheme on Southeastern franchise area. Franchise due to start December 2018.	5 – 10% reduction in delay minutes Performance and safety	£75m (already approved)
TOTAL	£175m			Range c.£450m – c.£650m

See notes to Table 5 overleaf

Note – It is Digital Railway Programme's aim to reduce the cost of command, control and signalling. Where schemes are still in the early stage of development, all delivery costs estimates are rough order of magnitude costs, they are

1. Provisional and expressed as a range
2. Upper bound
3. Not an Anticipated Final Cost for a contract
4. Contain a wide range of risk/optimism bias.

Notes to Table 5

In July 2017, £85m was allocated from the NPIF for fleet fitment and test facilities at RIDC/ENIF. On 4 September 2017, a DfT SOBC, setting out a menu of schemes was approved by DfT's investment body, Board Investment and Commercial Committee (BICC), which also authorised £5m funding to develop the South East digital upgrade (excluding the south East franchise area) to OBC. In addition, a budget of £75m was confirmed for a new South East franchisee to develop, design and deliver TM for its train service area. This funding, for the 'TM in Southeastern Franchise' (shaded orange in table above), has been approved subject to DfT receiving a satisfactory bid in response to the Invitation to Tender.

Since then, funding of £5m has also been announced for draw down from NPIF to explore digital opportunities as part of the TransPennine Route Upgrade (TRU) and £5m authorised for development of a digital upgrade of the Moorgate branch.

For all schemes shaded blue in the table above, funding has only been approved for the development phase, after which further funding will be subject to approval at the outset of both the design and deliver phases, when greater evidence of the costs, benefits and deliverability of each scheme will be available. The development phase is expected to be completed by the end of 2018.

It should be noted that the amount available in the NPIF is insufficient to cover the development and deployment of all the candidate schemes listed above, therefore a selection process will be required to narrow this list down, or additional funding will be required. This approach will mitigate against the risk of delays to the Digital Railway Programme if some of the schemes we are currently developing are found at a later stage to be undesirable.

Given the need for enabling work and development to be ready in time for deployment in CP6, wider system implementation should commence as soon as possible, overlapping with delivery of early deployments.

⁸

3.1.2 Programme Management

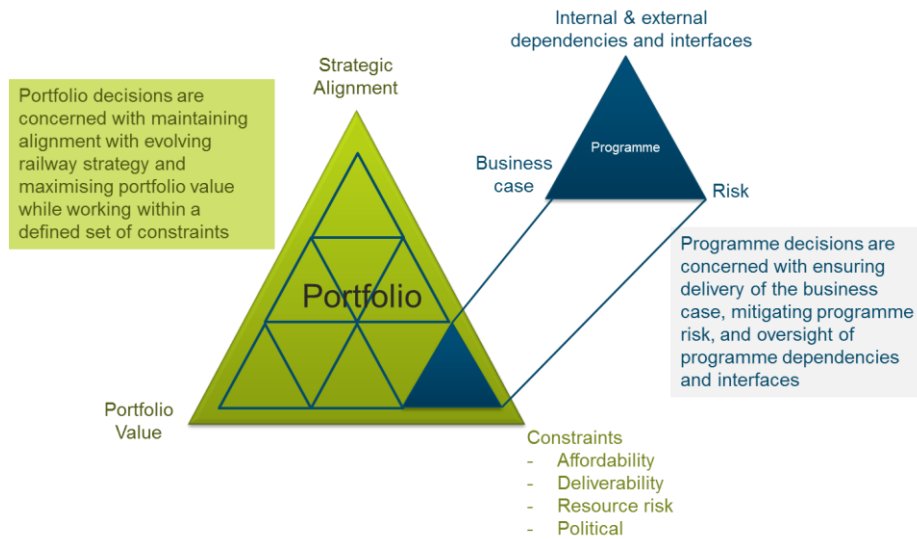
The schemes described above are subject to affordability and deliverability constraints that will need to be considered across the whole portfolio, reflecting the balance of contributions each scheme makes to the overall portfolio on three measures:

- Value;
- Strategic alignment;
- Constraints / risk.

This is described further in the portfolio management diagram overleaf (Figure 5).

⁸ The following text has been deleted: "BICC has now also approved the bringing forward from CP6 to CP5 of £500m to smooth the level of renewals activity across control periods. Digital Railway is examining opportunities for some of its activities to be accelerated using a portion of this £500m." This was originally included in error in the published SBP. Pre-publication of the SBP, and before any final decisions on re-profiling spend had been taken, it was decided that BICC's conditional agreement could not ultimately be supported because too little time remained to give confidence that long term value for money could be secured through bringing forward expenditure from CP6 to CP5.

Figure 5: Portfolio management approach

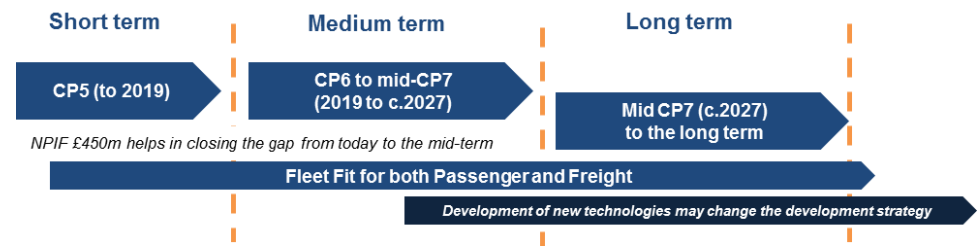


Exploration of the best strategic fit between the schemes is being fed into the development of an integrated programme to take account of the constraints to delivery across the network.

An integrated schedule has been developed to manage these issues and is subject to continuous development through programme scenario planning, to recommend the optimal balance of activity.

The programme's delivery strategy reflects activities delivering outcomes over the short, medium and long term, some of which run in parallel with each other (Figure 6).

Figure 6: Programme delivery strategy



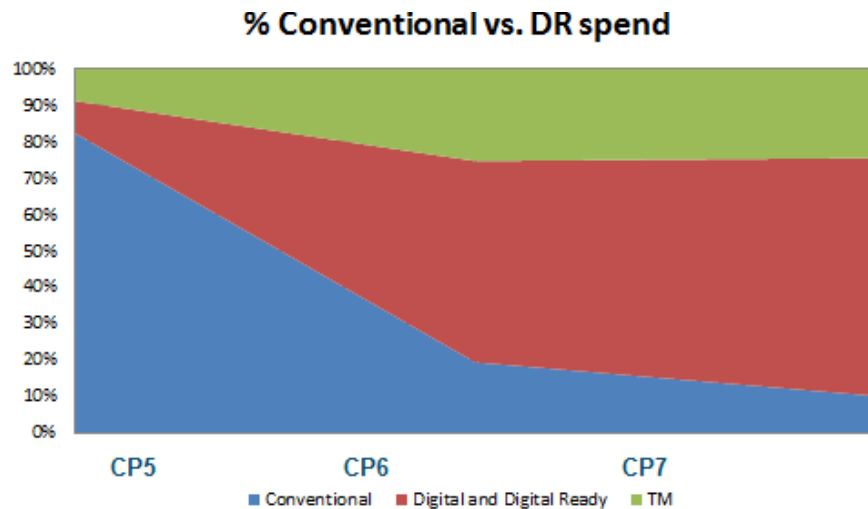
Short Term: Committed projects and learning lessons

Focused on key projects in 2017 and the remainder of CP5 that will deliver benefits through current demonstration of digital train control at Thameslink, Crossrail 1, Romford, Cardiff and Didcot. The costs included in this Digital Railway Programme Strategic Plan reflect those elements that fall within the Digital Railway Programme, for early deployments in CP5, of TM at Romford, Cardiff and Didcot, but not deployments within the Thameslink and Crossrail projects, which are outside the Digital Railway Programme's control.

Medium Term: Targeted deployments

CP6 is expected to mark a turning point for digital deployment as digital railway-ready infrastructure combines with more fitted trains (Figure 7 overleaf) and the rollout of digital train control, traffic management and connected driver advisory systems. These combined effects are illustrated in Figure 2 in Section 2 above.

Figure 7: Indicative transition from conventional full re-signalling schemes to digital railway



Notes to Figure 7:

- (i) Assumes all digital railway funding aspirations are met for CP6/7 and implementation decisions are made according to DRP’s integrated schedule.
- (ii) Excludes assets such as level crossings, minor works, etc.

In the short to medium term, a package of work is being funded from HM Treasury’s National Productivity Improvement Fund (NPIF) to deliver systems integrated solutions and early adoption of the early contractor involvement approach (see Section 5.3 below) to outcome-based supply chain delivery. These activities, using available systems and operating methods, will deliver enhanced benefits on targeted sections of the network and enable validation of a consistent national toolkit.

Approved funding for enabling schemes is reflected in

central programme costs and for South East Route’s OBC scheme development in that Route’s Strategic Plan. Costs of other candidates for this fund are not represented separately in the Digital Railway Programme Strategic Plan, as (on authorisation) they will represent a funding contribution to the Routes’ schemes (see section 3.2 below).

Funding of wider system implementation will need further discussion with DfT, including consideration of a mix of SoFA and specific DfT funding, driven by enhancement business cases for targeted schemes and enabling projects required for Routes to deploy digital technology (see section 5.1). These deployments will employ an integrated systems approach using a validated toolkit and a tested approach to supply chain engagement focused on outcome delivery, reflecting the lessons of early deployments.

Each scheme will be based on individual business cases. The economic appraisal of these medium term schemes is based on a long term programme and therefore shares central costs over multiple deployments. National enablers managed by the Digital Railway Programme include ETCS in-cab fitment, test facilities and telecoms upgrades.

Longer Term: Digital as the default

Digital Railway is developing a longer term strategy, assumed to be based largely on asset condition, to complete the network (asset renewal whole life cost saving business cases) within the notional life of command, control and signalling assets. It is assumed therefore that in subsequent funding cycles, candidates would again be prioritised by value. This will also include traffic management and control strategies.

3.1.3 Technology

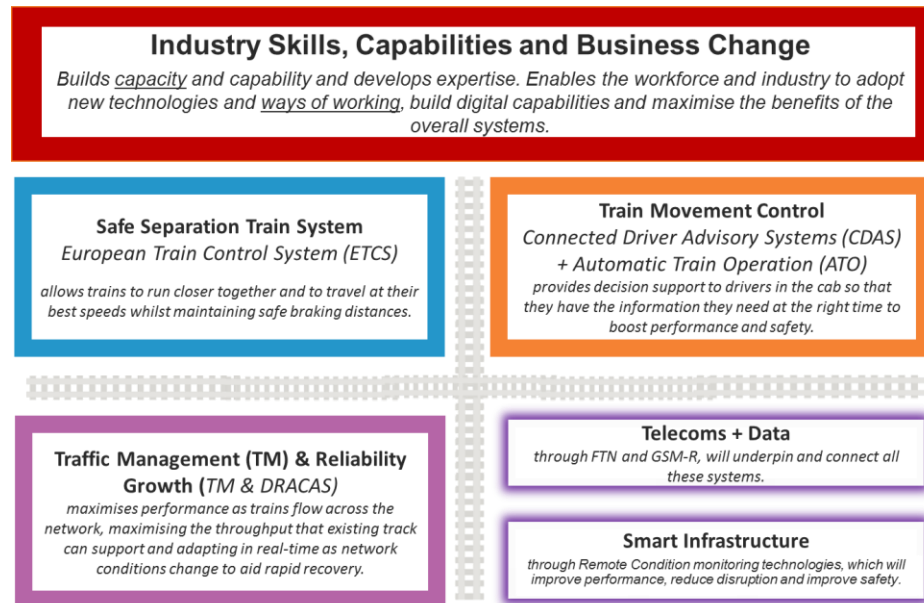
An overview of the systems, technologies and business change contained within Digital Railway is set out in Figure

8 below.

This includes enabling activities such as upgrading of telecommunications and data systems through FTN and GSM-R to meet enhanced ETCS availability requirements, as well as helping to make available critical asset information to inform decisions about asset management using tools developed by Asset Information Systems (AIS) and Enabling Better Asset Knowledge (EBAK) teams.

Figure 8: Scope of the proposed Digital Railway programme

The digital railway brings together systems, technology and business change in an integrated way



Development of new technology

At this stage work is being undertaken to set out the requirements for development of new technology and this is being funded from CP5 central Digital Railway

Programme funds. This is largely being undertaken through development projects. Network Rail is considering whether further R&D on digital technologies should be funded or specified by the Digital Railway Programme or by STE and to what extent the supply chain can best help drive disruptive innovation. A Joint Development Group (see section 3.2 below) is proposed as the vehicle for delivering this level of business change.

3.2. Operating model – present & future

The digital railway is focused on solving real problems and challenges faced on the network today, through:

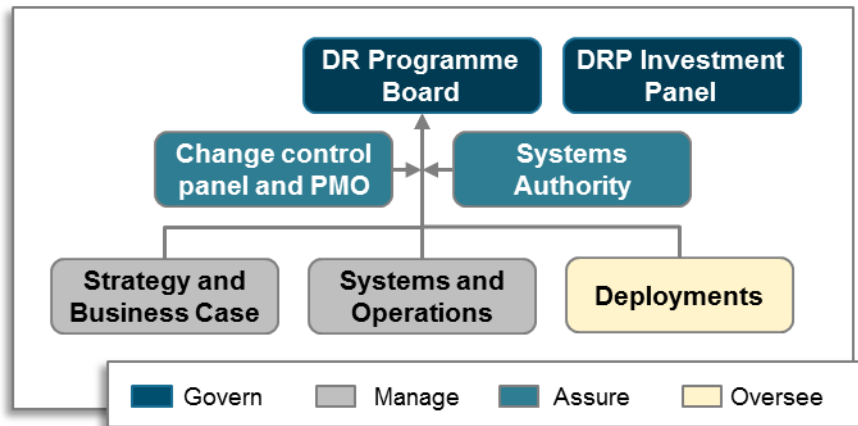
1. Adopting a route-centric approach with cross industry involvement in the production of business cases to support funding decisions.
2. Solutions based around 3 proven technologies which can be deployed today (see opposite and Appendix G) and are accepted by rail industry partners as the right solutions.
3. Identifying candidate schemes based on alignment between performance, capacity and safety needs and renewals and franchising opportunities. Conventional signalling interventions in advance of digital deployments incorporating digital ready specifications.

Governance arrangements for the Digital Railway Programme recently agreed with DfT are illustrated overleaf (Figure 9) and came into effect in November 2017.

This approach creates a simplified structure (compared with previous approaches) that will align with the programme’s new operating model and Industry programme management office (PMO), with NR’s corporate processes and with DfT/NR’s enhancements MoU. The fora remaining will be more focused on outputs,

enabling transparent and stronger decision making supported by clear roles and responsibilities shared along key interfaces with industry and NR Routes.

Figure 9: Governance structure



Projects will be managed in a co-ordinated way, regardless of funding source and resulting governance variations, whether early CP5 deployments, candidates proposed for funding from the £450million NPIF fund, or accelerated medium term activities that may be funded from the £500m brought forward from CP6. Similar project co-ordination will be in place for CP6, where funding may be drawn from the NPIF fund, allocations from the regulatory settlement or through other enhancement business cases. This will enable consistent application of core Digital Railway Programme approaches, skills and capabilities to maximise cost efficiency and interoperability of technologies across the network.

As funder approval is granted for some or all of the NPIF SOBC and Route funding submissions, the relevant Routes, the Digital Railway Programme team, and other key stakeholders will agree their more detailed roles, responsibilities and working relationships reflecting the

number of projects likely to be progressed in CP6. They will then be able to choose the best balance of local ownership versus central co-ordination and oversight, clarifying how the ‘thin client’ approach should work in practice to meet their needs.

Preferred way forward for CP6/7 – subject to business cases and funding

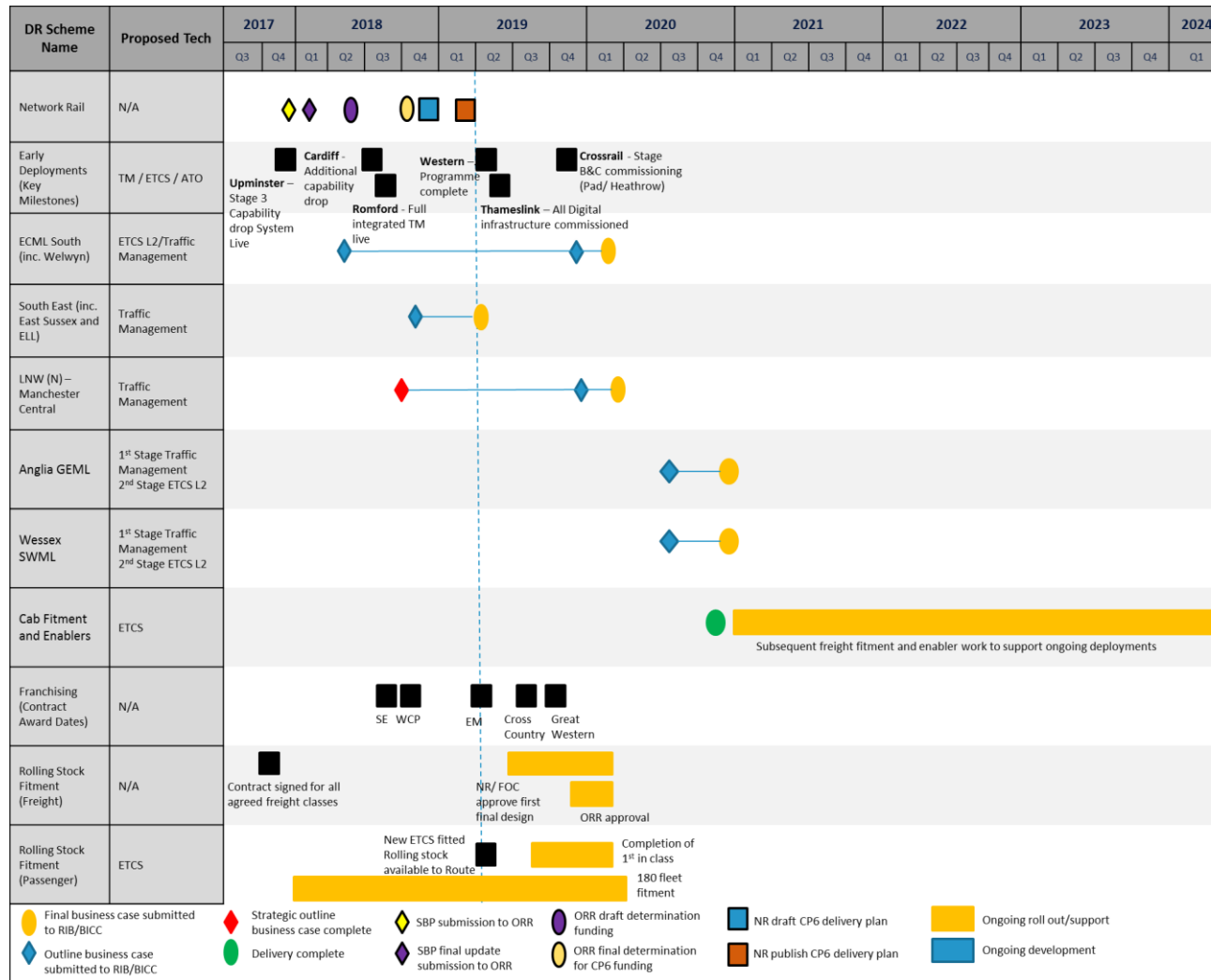
A roadmap for digital railway rollout showing planned progress to the end of CP6 is set out overleaf (Figure 10). All listed activities in CP6 are subject to business cases and funding.

Overall consolidated programme expenditure shown in Table 5.1 is required to provide for: (i) Digital Railway Programme’s structure as set out in section 3.1, (ii) essential enabling activities e.g. train fleet fitment and (iii) the Route deployments which the core team will support and co-ordinate, as outlined in the delivery strategy in section 3.1.2. This:

- reflects decisions to progress to OBC of ETCS and TM schemes on LNE Route (Welwyn area and Moorgate branch) and of TM on South East Route;
- assumes initiation of ETCS/TM schemes on Anglia and Wessex Routes as part of DfT’s review of Network Rail’s pipeline of enhancements business cases;

For other candidates being considered, such as additional NPIF-funded studies set out in Section 2, the programme anticipates that these will be subject to change control and added to the consolidated expenditure plan in a controlled manner upon agreement to progress with funders. This includes ETCS and TM schemes for the TransPennine Route Upgrade, ETCS and TM schemes on LNW Route (including Manchester area and Crewe) and studies on the Wessex suburban line (Feltham area) where the case for digital railway substitution of conventional signalling renewals are anticipated.

Figure 10: Digital Railway provisional integrated schedule for CP6-7 (subject to business cases and funding)



Note: Routes' milestones up to date as at January 2018

To support required scenario planning, a central scenario is set out in Appendix D, based on progression now of three schemes for CP6: TM in South East Route and the preferred way forward for ETCS and TM in LNE & EM Route, alongside TRU. These represent the best value TM scheme (South East) and the best value ETCS scheme (LNE & EM). TM in LNE & EM Route becomes the next best value scheme after the South East when deployed in combination with ETCS on LNE & EM Route.

In addition, to support the uncertainty analysis, a 'NPIF funded only' scenario is set out in Appendix D, reflecting expenditure on progression of TM in the South East only.

The Digital Railway Programme will seek to drive costs down further for all digital upgrades by revolutionising Network Rail's supply chain relationship (see Section 5.3 on efficiency and the Early Contractor Involvement, ECI work stream).

A Joint Development Group (JDG) concept is being explored by the programme, to formalise the successful ECI process, to streamline design and development of digital schemes through a cross industry virtual team, including supply chain partners. This is an important change – our digital supply chain will be involved far earlier in the process than currently – at development stages. By the start of CP6, it is intended that the JDG will act as a service provider to the industry, routes and major infrastructure programmes with the ability to deliver specific technical outputs to support business strategies and project delivery/development (nominally GRIP 1-3 activities) to output/performance specifications.

Delivery models under consideration

Although at this early stage traditional funding sources have been assumed for costing purposes, Digital Railway is exploring different commercial procurement models as a result of the ECI workstreams. Procurement needs to start

in 2018 to deliver in CP6 including innovative elements such as:

- Outcome based specifications
- Whole-life relationships, enabling the possibility of locking in a whole-life price
- Innovative payment structures that incentivises in-service performance and reliability
- Closer relations with the Supply Chain and earlier involvements than is currently the case
- Thin Client model with a risk-based client oversight role
- Technology risk transfer

The measures above would also facilitate the potential for third party financing or funding (contributions) and this is currently being explored.

The Digital Railway Programme is currently considering commercial packaging and delivery options as well as various financial models. All models will be evaluated against identified 'red lines' as well as commercial objectives. These considerations will lead to fully developed recommendations as part of the next phase of OBC development.

Emerging findings from the packaging workstream point to:

- Splitting ETCS and TM delivery to attract a wide pool of suppliers in order to achieve best value for money
- Splitting the on-train elements of ETCS, CDAS & ATO from those elements that are on-track or in the Operating Centres. This allows for financing via the ROSCOs, which has off-balance sheet status.
- Utilising the franchising process to partner with franchisees in the delivery of digital technologies, such as isolated traffic management.

4. Risks, opportunities, constraints and assumptions

Summary of objectives		<ul style="list-style-type: none"> Integration into Routes' and central functions' Strategic Business Plans to address asset sustainability. Targeting deployment of digital train control and signalling systems to address current and future capacity and performance issues. Aligning to Route plans for consolidation of 'areas of control' for operational efficiencies. Aligning with and influencing of franchising to future-proof industry cost. Continuous safety improvement. 		
No.	Key constraints, risks and opportunities	What we plan to do	Owner	Timescale (start/ finish)
1	<p>R: Failure to be ready to deploy 'Digital Railway Train Control and Signalling Systems' to deliver the requirements for the targeted schemes within CP6 due to:</p> <p>1) Funding is not secured beyond initial £450m, 2) Supply chain lacks capability/capacity to support new delivery role / relationship and timescales, 3) Early deployments do not adequately demonstrate the benefits in a timely manner, that underpin the business cases for future schemes, 4) 3rd Party funding/financing not available in time to support schedule, 5) Uncertainty around the Cyber threat & Digital Railway System resilience</p>	<ul style="list-style-type: none"> Assess options and agree funding and financing approach with DfT and Treasury for entire programme Involve contractors early and develop engagement models Agree the role of the supply chain in a Unified Supply Chain Strategy for Signalling and Train Control across all the Routes Work with PFI specialists to develop finance options Secure permission to enable flexibility for innovative approach in financing Define and agree an integrated industry-wide plan with clear delivery accountabilities and monitor performance through effective industry governance Develop a robust Industry Risk Register, propose mitigating actions and seek industry endorsement Monitor quantity of benefits from deployments and ensure transfer of lessons learned across the programme 	MD, GDR (because programme is designed to address this risk)	Continued effort throughout CP5 and CP6
2	<p>R: Failure to secure the drawdown from £450M already approved by DfT in a timely manner to permit early investment in DR infrastructure and deliver the user benefits intended arising from:</p> <p>i) Prioritised schemes not supported by Wider Government,</p>	<ul style="list-style-type: none"> Early engagement with DfT and Treasury to ensure timely & positive funding decision-making Produce high quality drawdown requests Further develop the pipeline of candidate schemes (Strategic Business Plan) Develop an Agile procurement mechanism and documentation to get into contract (with Delivery Supply-chain) in a timely manner within the specific time constraints for the £450M funding 	DRP's Head of Investment Strategy, Franchising and Sponsorship, Head of Industry PMO, Finance Director and Routes (Anglia, LNE & EM, South East and Wessex)	Continued effort throughout CP5 and CP6
Network Rail				25

	<p>ii) DRP failure to develop attractive business cases, iii) Failure to secure funding approvals, iv) Inability to get into contract with delivery supply chain, v) Early deployment schemes do not adequately demonstrate the benefits.</p>			
3	<p>R: There may be insufficient capability or capacity to support the Digital Railway programme delivery from CP6, including technical capability and supply chain capacity, due to:</p> <p>i) Uncertainty for Industry around planned DRP pipeline and contractual commitment; need to go to market by mid 2018, ii) Insufficient market appetite, iii) Uncertainty around Systems requirements, iv) Difficulty and expense of securing regulatory approvals and approvals to proceed, v) Client capability, lack of intelligent customer, with appropriate capability and experience; fragmented client organisations/ multiple clients and interfaces/dependencies</p>	<ul style="list-style-type: none"> Develop funding/finance stream to underpin market appetite and confidence Investigate appetite for third party finance from the supply chain Develop outcome based commercial model to drive innovation, investment and incentivise long term Supply chain performance Develop 'Agile' procurement mechanism and documentation Increase supply chain engagement and establish DRP interim work-stream to manage Supply chain engagement in the short and in the medium, including visibility of Industry Schedule 	<p>DRP Head of Investment Strategy, Franchising and Sponsorship, Head of Industry PMO, Commercial Director</p>	<p>Initiated in year 3 of CP5 and sustain throughout CP5 and CP6</p>
4	<p>R: The early DR Traffic Management deployments may fail to demonstrate sufficiently the benefits of DR products undermining the business cases for future deployments due to:</p> <p>i) System functionality does not meet operational needs ii) End users do not optimise System use, iii) Route Operating Model does not support benefits realisation, iv) Delivery is delayed, v) Negative impacts from non-directly managed early deployment schemes (Crossrail 1, Thameslink)</p>	<ul style="list-style-type: none"> Build Route commitment to benefits realisation, support development of post implementation operations, ensure Route delivery of required training Maintain established TM Governance processes in accordance with IP procedure Work with Sponsors/Business Change Managers to ensure engagement with operational teams and ongoing stakeholder review progress Harvest benefits realisation from early schemes to substantiate applications for funding 	<p>DRP's Head of Investment Strategy, Franchising and Sponsorship, Head of Industry PMO, Finance Director and Routes (Anglia, LNE & EM, South East and Wessex)</p>	<p>Initiated in year 3 of CP5 and sustain throughout CP5 and CP6</p>
5	<p>R: Lack of Funding or appropriate Financing</p>	<ul style="list-style-type: none"> DfT agreement being sought to joint DRP/DfT programme strategy. 	<p>DRP's Head of Investment Strategy,</p>	<p>Initiated in year 3 of CP5 and sustain throughout</p>

	<p>availability to support the Digital Rail Programme development & delivery, due to:</p> <p>i) Central Government Funding not available, ii) DRP business cases are not attractive, iii) Failure to secure funding / financing approvals and /or DR qualification for 'off balance sheet' approach, iv) DR is not an attractive investment for Private / Third Party Finance</p>	<ul style="list-style-type: none"> • Documentation of cross industry requirements aligned to technical capabilities of systems. • Documentation of baseline schedule plan. • Ongoing engagement with Route and Principle Strategic Planner community to maintain alignment between agreed funding and financing approach with DfT and Treasury for entire programme • Building in DR costs into the Strategic Business Plans • Secure early agreement on 'off-balance sheet' approach (for ECML south Business Case) • Define the DR delivery and the Single Supply Chain Strategy. 	Franchising and Sponsorship, Head of Industry PMO, Finance Director and Routes (Anglia, LNE & EM, South East and Wessex)	CP5 and CP6
6	<p>R: Failure to deploy TM protection and SCWS will reduce possible DR benefit realisation.</p> <p>Deployment of these technologies will provide complementary safe and efficient access to the infrastructure to undertake required inspection and maintenance. Without these systems DR technology will reduce access opportunities and could impact train performance counter to the DR business case benefits</p>	TBC	TBC	TBC
7	<p>R: Failure to deploy TM protection and SCWS will result in possible ORR enforcement action on DRP or Routes</p> <p>ORR view is that these technologies are reasonably practicable. Failure to deploy where possible would breach safety by design principles in CDM Regs.</p>	TBC	TBC	TBC
8	<p>R: Failure to adopt EULynx will mean SCWS will need individual interfaces to each system</p>	TBC	TBC	TBC
9	<p>O: Boosting train control and performance through connected systems</p>	The Programme is examining how people and processes can improve the performance of passengers and freight customers' train journeys through the adoption of digital support tools for signallers, drivers and controllers.	DRP Director Operations and Transformation	Continued effort throughout CP5 and CP6
10	<p>O: Capacity to accommodate demand</p>	Much of the signalling infrastructure currently in place is based on the principle of dividing tracks into fixed sections. The fixed sections are not optimised for all services, as a result, trains which could safely run closer together are	DRP Director Operations and	Continued effort throughout CP5 and CP6

		barred from doing so, resulting in a network that is under-utilised, with an impact on frequency of service and journey times. The Programme is working with NR capacity planning teams to develop ways to use additional capacity this creates (both from deploying currently available technologies and those still being developed).	Transformation and NR system operator team	
11	O: Real time information	Train operators and supply chain partners, as part of the Digital Railway Programme, are examining ways to realise benefits of improved information available in real time as a part of deploying digital technologies	DRP partners	Continued effort throughout CP5 and CP6
12	O: Potential to reduce cost	Conventional signalling systems require a great deal of expensive work to create a highly bespoke design for train drivers to sight signals and cater to the specific characteristics of a section of track. Once installed, these systems then require expensive renewals work, further increasing costs for the network into the future. Continuing Early Contractor Involvement is intended to focus on cost effective commercial structures through innovation and collaborative contractor relationships.	DRP Commercial Director	Initiated in year 3 of CP5 and sustain throughout CP5 and CP6
13	O: Improve skills Developing next generation skills essential to continued success of the UK economy.	The ongoing evolution of the skills, knowledge and expertise that Digital Railway will bring will provide a benefit which can be transferred to other infrastructure sectors ⁹ . The DfT's Transport Infrastructure Skills Strategy –“Existing staff will need greater systems engineering, advanced telecoms, software programming and crucially business change skill sets to help fully realise the benefits of a digital railway” ¹⁰ . Successful development will build upon the industry's existing capability, and give the opportunity to boost exports; As well as building rail capability, Digital Railway can also enable skills to be realised across other industries – by bringing about agglomeration benefits that allow greater connections between skills and jobs, and goods with markets. Digital Railway has the potential to extend the catchment area of major cities. Accelerating these benefits could unlock additional productivity and economic growth for the UK economy. Funding is currently being sought for the setting up of a skills academy to realise this opportunity within a wider people and training plan.	DRP Operations and Transformation Director	Initiate in year 4 of CP5 and sustain throughout CP5 and CP6
14	O: Accelerate infrastructure deployment benefits Accelerate in-cab fitment of digital upgrades to realise whole system benefits of infrastructure upgrades	Opportunity to influence DfT to require franchise bidders to specify any new vehicles in their bids to be delivered with ETCS fitted, where infrastructure deployment plans exist or otherwise ETCS ready.	DRP Head of Investment Strategy, Franchising and Sponsorship	Initiated in year 4 of CP5 and sustain throughout CP5 and CP6
15	O: Introduction of TM protection and SCWS will contribute to NR enterprise risk reduction targets	TBC	TBC	TBC

⁹ Institution of Civil Engineers (2016) “The case for internalising externalities in a sustainable rail asset base” p1

¹⁰ Department for Transport (2016) “Transport Infrastructure Skills Strategy” p 42

4.1. Notable assumptions

There is a programme wide key assumption that development funding is provided in CP5 for progression of the Digital Railway SOBCs to the next level. NPIF is the source of some of this funding, but if not all, an alternative source is required.

The consolidated programme-wide expenditure summary set out in section 5 below is required to provide for the central programme team supporting South East, Anglia, LNE&EM, and Wessex Route SOBCs' preferred ways forward, alongside development of upgrade schemes currently being investigated, with scheme development in South East and LNE&EM Routes starting in October 2017. Affordability and deliverability of this level of activity is currently being examined to develop a recommended optimal balance of activity. Consideration of other parts of the network for digital upgrade business case development to meet further demand for digital railway technologies (see NPIF candidate list above) may lead to reprioritisation and rescheduling of the activity plan.

For the Route Digital Railway SOBCs completed to date, some critical assumptions have been made around investments enabling the Digital Programme, which are set out in each Route's Strategic Plan.

5. Consolidated programme expenditure & efficiency

This section describes expenditure and efficiency for the whole programme, consolidating costs across all Routes' and central business units' Strategic Plans in CP6 only where they relate to deployment of digital train control and signalling systems. Costs for the Digital Railway Programme business unit are set out in section 6.

This plan is predicated on the notable assumptions laid out below and will be impacted as these assumptions change.

5.1. Consolidated programme cost and volume summary

These consolidated whole programme cost estimates have been developed to SOBC requirements, so contain significant allowances for optimism bias. They are indicative optimistic scenario point estimates and are best seen in the context of cost ranges reflecting sensitivities (as described in section 5.3 on financial certainty below) as actual costs may not align with these point estimates.

Summary of consolidated programme costs by Route or central function

Activity/team	CP6 total (£m)	Overall scheme comments
LNE & EM SOBC	572	ETCS Level 2 no signals; interfaced Traffic Management between London King's Cross and Stoke Tunnel including the Moorgate branch and Hertford loop and option for C-DAS, including business change, franchised operator cab fitment and conventional enabling enhancements.
South East SOBC	210	Integrated Traffic Management for the area controlled by Three Bridges ROC, primarily the Brighton Main Line, isolated Traffic Management for the remainder of the route, option for C-DAS, including business change and franchised operator cab fitment.
Anglia SOBC	219	Early development costs for ETCS level 2 no signals deployment in CP7 between Stratford and Chelmsford, integrated Traffic Management between Liverpool Street and Colchester/ Stansted, isolated Traffic Management on the North London Line, GOB, and to Ipswich/Felixstowe, option for C-DAS, including business change, franchised operator cab fitment and conventional enhancements to support capacity benefits - Witham Dynamic loops, Trowse Swing Bridge Doubling and Liverpool Street platforms.
Wessex SOBC	107	Early development costs for ETCS Level 2 no signals deployment in CP7 between London Waterloo and Woking, Integrated Traffic Management London Waterloo to Woking and isolated Traffic Management across the rest of the route, option for C-DAS, including business change, franchised operator cab fitment and conventional enhancements to support capacity benefits - Up Main Relief line extension to Vauxhall, Feltham Depot, Power Supply Upgrade, London Waterloo passenger capacity.
Freight and National Passenger Operators	268	Fitment of ETCS to freight (£238m) and heritage vehicles (£30m) and associated business change support

Digital Railway Programme - core	180	Rail system authority, industry PMO and programme strategy & business cases. National enabling projects such as telecoms system upgrades (GSM-R), test facilities (ENIF, RIDC and systems integration lab), TM maintenance and support for Wales and Anglia Routes
Route Services	119	Fitment of ETCS to on track machines (NR and third party) and business change support. Signaller training centre costs. Maintenance of IT systems enabling deployments of digital train control and signalling technology.
Franchisee Costs (Non-NR)	173	Assume to be funded via the Franchisee process rather than the Network Grant process and would be experienced as a lease cost from ROSCOs spread over time.
Total	1,848	

Basis for costs

These indicative cost estimates are prepared on an industry level and therefore include not just Network Rail costs, but also include the TOCs', FOCs' and ROSCOs' spend to deploy Digital Railway technology in each Route. The cost estimates have been prepared on a first deployment basis, assuming delivery of a programme of three ETCS projects and four TM deployments in Control Period 6-7 (CP6-7) – 2019-2029 (see indicative deployment plan figure in section 3.2 above). They therefore contain a cost premium which is anticipated to reduce over time due to a learning effect within the industry as well as a changed procurement approach.

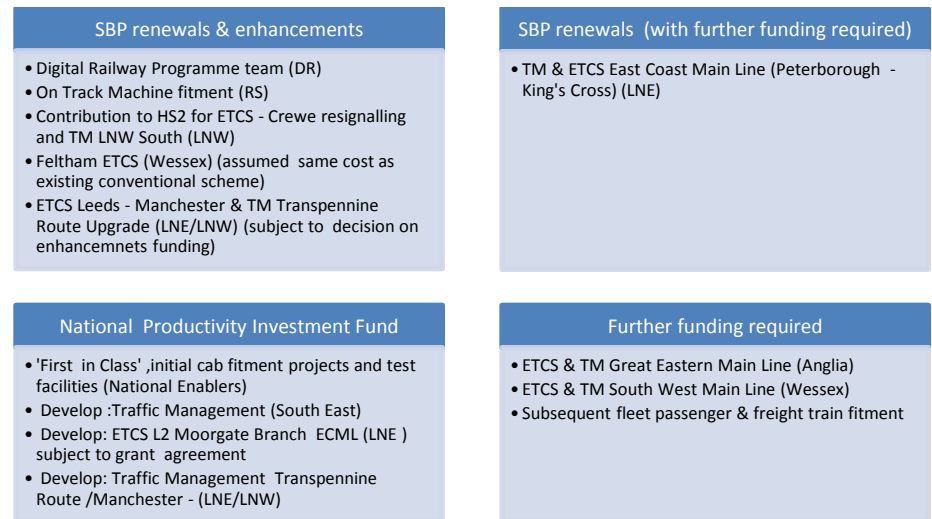
The Digital Railway Programme has worked with Route Businesses to agree how they include the forecast expenditure in their Routes' Strategic plans. The ultimate CP6 funding requirement will depend on how many schemes are taken forward for development and delivery in CP6 (as discussed in section 3 above).

The net funding amounts shown above, corresponding to the digital railway elements of Routes' Strategic Plans, represent the additional funding required above that which would be required to fund conventional renewals planned by Routes prior to integration with the Digital Railway Programme and committed supporting enhancements. The Digital Railway Programme has supported the Routes in change controlling their previously planned (up to RF2)

conventional re-signalling spend (see notable assumptions in section 4.1 above) to fund renewal via digital means in the areas where these will be delivered in CP6/7. The programme is working with the planning community to mitigate abortive costs and rework.

The initial digital schemes' current funding position is summarised in Figure 11. We are exploring alternative funding and financing options, where appropriate, and aim to have to have developed proposals by the end of 2018.

Figure 11: Digital funding pipeline and the Strategic Business Plan (SBP)



The scheme costs in the table above do not include the cost of existing rolling stock orders for digital railway fitment or digital railway readiness. These costs are borne by the relevant passenger train operator (including open access). Where schemes under consideration have not yet been developed to SOBC, cost estimates are not included in consolidated whole programme costs.

Costs for schemes in the table above are based upon traditional procurement and delivery. This means that the costs could vary, depending on the chosen delivery method (as discussed briefly in section 3.2 above). The implications of alternative delivery models and utilising third party financing will be explored as part of the OBC phase.

The consolidated programme's costs are made up of several components:

- Integrated within Routes' Strategic Plans
 - ETCS infrastructure schemes (including enabling telecoms costs for FTN and GSM-R to provide availability that meets enhanced ETCS requirements) and passenger operator cab fitment costs that will be borne by the operators
 - Traffic Management schemes
- Freight fitment national costs which will be in the Freight and National Passenger Operator Route Strategic Plan
- Wheeled plant costs, signaller training centre costs and IT maintenance costs, which will be in the Route Services function's Strategic Plan
- Central Digital Railway Programme function's Strategic Plan – costs for programme management, System Authority, enabling projects (such as national test facilities and core telecoms upgrades for ETCS), maintenance and support costs for TM in Anglia and Wales and limited funding to support development of further scheme problem statements and SOBCs. This

element is also shown separately in this function's Strategic Plan.

These consolidated whole programme cost estimates have been developed to SOBC requirements, so contain significant allowances for optimism bias. They are indicative point estimates and are best seen in the context of cost ranges reflecting sensitivities (as described in section 5.3 on financial certainty below) as actual costs may not align with these point estimates.

Schemes will need to be reflected in franchise agreements and sufficient access agreed within contracts to deliver the outputs. These costs have not yet been agreed and so are not included in this plan. As schemes are developed and more detailed access needs are identified, as for other such investments, the programme will work with train operators through the Network Change process to minimise costs to the programme and develop the optimal solution for the industry.

5.2. Route Business Scotland details

Only Digital Railway readiness for existing renewals has been assumed in Scotland. It is assumed this is at no material additional cost.

5.3. Cost drivers, headwinds and efficiency for consolidated programme expenditure

In CP5 the Digital Railway Programme has been focused on developing a programme strategy, technological system requirements and test facilities, concepts of operations, pilot deployments to learn lessons, business cases for larger targeted deployments, and an integrated schedule of work and industry stakeholder engagement. As the programme moves into a very different level of activity, as part of wider system deployment in CP6, it is not meaningful to compare the programme's costs from one control period to the next.

Summary of consolidated programme capex headwinds and efficiency

Capex	Year			Year					CP6 total
	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24	
At current cost level (£m)	48	90	64	210	321	420	438	459	1848
Head winds (%)									
Efficiency (%)									
Post efficient spend (£m)	48	90	64	210	321	420	438	459	1848

Note: CP6 total includes £194m conventional re-signalling costs on ECML substituted for digital railway

Headwinds and efficiency estimates are included in Routes' Strategic plans as part of their deployment schemes, but are not relevant to all programme costs, so not shown here at the consolidated whole programme level. These are illustrative to meet regulatory requirements, but were included in SOBC estimates.

However it should be noted that these indicative cost estimates have only been developed to the level required for SOBCs, so post efficient spend for the optimistic scenario is best seen in the context of cost ranges reflecting sensitivities (as described in section 5.3 on financial certainty below).

Headwind details – for digital upgrade schemes

Area (capex, opex)	Head wind name	Description	Mitigating actions	%
Capex	Remobilisation	Remobilisation costs if funding is not forthcoming during CP5 to develop preferred way forwards in readiness for deployment in CP6	Avoidance of a stop-start investment approach	+30

Efficiency details – for digital upgrade schemes

Area (capex, opex)	Efficiency name	Type of efficiency	Description	%
Capex	ECI	Cost reduction	Early Contractor Involvement to make visible a committed programme of works	-30

Early Contractor Involvement (ECI)

The supply chain is a key stakeholder in credibly delivering the plan for a Digital Railway. So the

Programme has engaged extensively with the supply chain to investigate the appetite for an innovative and collaborative based approach via an ECI workstream, including industry roundtables, case studies and a series

of supply chain workshops.

Appetite exists in the supply chain for a more innovative delivery approach, especially where the potential exists for achieving better value for money. Some of the key observations from the supply chain, on how they could better support the design, implementation and operation of a Digital Railway, are detailed below:

- Procurement of a whole life solution by a 3rd party, not just design and build, but also including planned and reactive maintenance ranging to potential operation over the life of the asset;
 - Design, test and routine maintenance should be included with the main contract as design and test are fundamentally linked. This needs to be included to allow for innovation, effective risk transfer as part of value for money, and reduced interface risk. Planned maintenance should be included as the supplier is the expert on their technology and therefore can manage this better;
 - Reactive maintenance should also be included in the contract. This allows effective transfer of whole life cost risk and would incentivise innovation to reduce maintenance requirements and therefore support value for money and innovation;
- Appropriate allocation of risk where suppliers commit to a whole-life cost;
- Output / outcome based specifications and contracts, allowing innovative solutions;
- Longer term strategic partnerships with earlier contractor involvement, clearer pipelines of work of a sufficient volume to encourage market innovation and supply chain investment in R&D, skills and training;
- Where the activity is 'business as usual' for Network Rail (i.e. the operation of the network, for which

Network Rail is ultimately responsible as the license holder), Network Rail is best placed to continue to perform this activity, especially where there are safety or operational interface implications.

This would typically lead to contract lengths matching the life of the asset, ranging 25-30 years.

Early Contractor Involvement evidence¹¹ suggests that a committed programme of works can help drive fixed costs down. The post headwinds and efficiencies costs presented have this efficiency (of approximately 30%) applied to them.

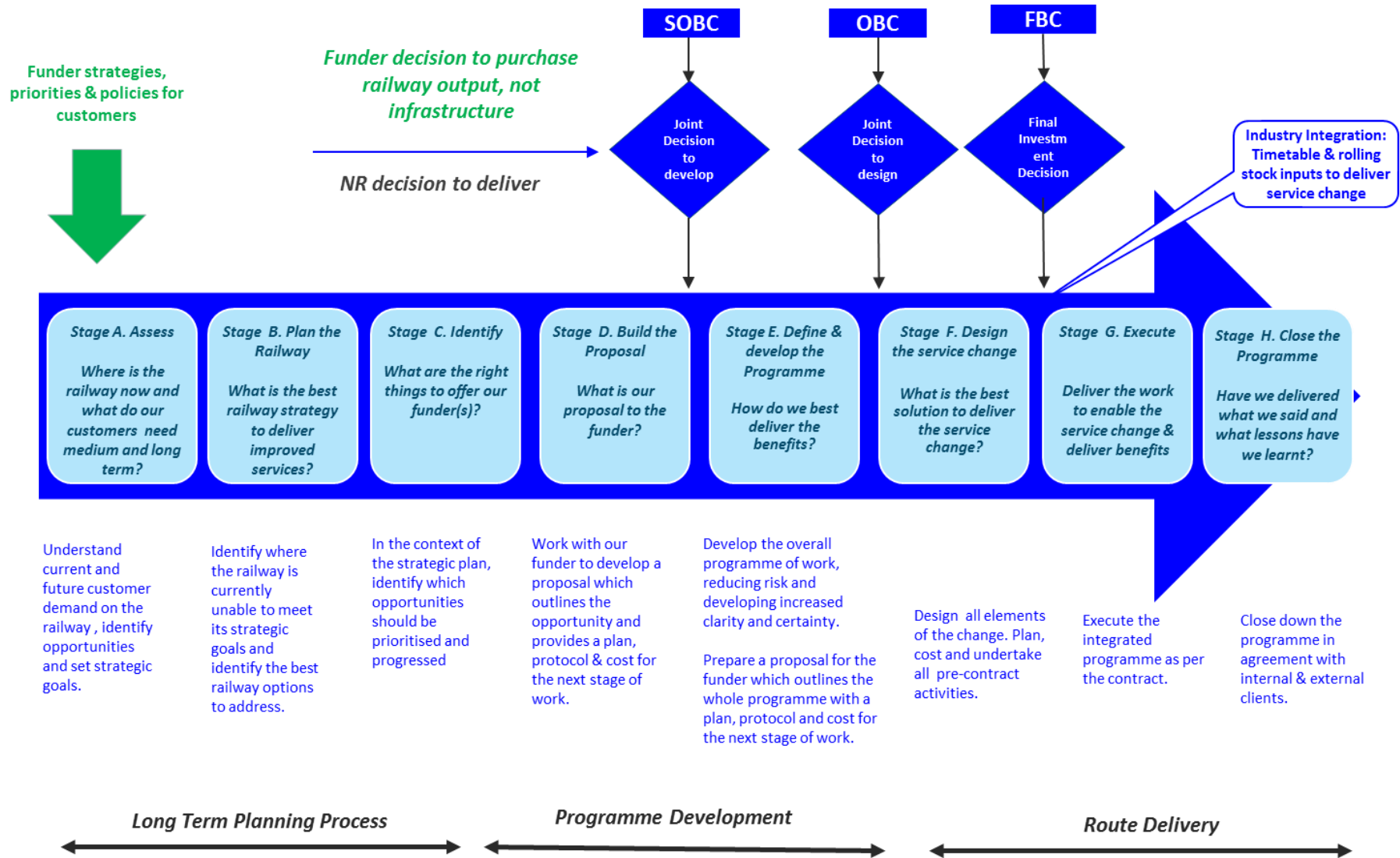
The above confirms that there is value in considering the Digital Railway roll-out as a programme of works, rather than incremental investment decisions. A programme will allow for better economies of scale and will ensure that items such as fixed programme costs are spread over a larger number of projects.

5.4. Risk and uncertainty in the CP6 plan for consolidated whole programme costs

The SOBCs which underpin the Route submissions were developed as part of HMT's 'Green book' process. This involves three steps of progressively more detail (Figure 12) developing firstly a clear understanding of the need and moving progressively to an investment decision.

¹¹ "Early Contractor Involvement Cost Reduction Findings Report" Version 0.20, Network Rail (2016)

Figure 12: HM Treasury’s ‘Green book’ process for developing investments



The information underpinning the Route submissions comes from their SOBCs and therefore at this stage of development there are still uncertainties. These will be refined over the course of the Outline (OBC) and the Final Business Cases (FBC). A change control mechanism is needed for this reason to mitigate the risk of changes. The other reason for a change control mechanism is the system-wide upgrade needed to support digital means multiple parties are involved in delivering the outcome. The change control mechanism needs to maintain this integration.

The change control process requires that all changes to any aspects linked to digital projects need to be brought to the Digital Railway change control panel if they relate to planned or committed schemes in terms of:

- Funding
- Cost
- Timescale
- Output

Financial certainty

See table overleaf.

The funding for these schemes forming part of the Digital Railway SOBCs is assumed to be ring-fenced so that if there are changes in cost (positive or negative) these will be governed by the Digital Railway change control panel and can be transferred between Routes, Central Functions and the Freight and National Passenger Operator. A consultation process with affected stakeholders and funders shall be completed prior to any change being submitted to the change panel.

The information in the table below, presents the Digital Railway Programme's estimate of the overall range of uncertainty across all affected business units' consolidated programme expenditure for CP6. We have also identified the main drivers of the uncertainty ranges for each scheme. The information in this table is based on the inputs for each of the programme's schemes and central programme-wide costs. Headwinds / tailwinds and efficiencies / inefficiencies are included in the spot estimates.

6. Digital Railway Programme business unit's expenditure & efficiency

This plan is predicated on the notable assumptions laid out below and will be impacted as these assumptions change

6.1. Digital Railway Programme business unit's cost and volume summary

Expenditure (post headwinds and efficiencies in 17/18 prices)

Unit of measure	CP5						CP6						CP7	
	14/15	15/16	16/17	17/18	18/19	CP5	19/20	20/21	21/22	22/23	23/24	CP6	24/25	
Renewals	£m	46	50	37	71	76	280	28	24	24	25	26	128	0
Controllable opex	£m	3	14	11	5	3	36	10	10	10	10	10	52	0
Non-controllable industry costs	£m	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	£m	49	64	48	76	79	316	39	35	35	35	36	180	0
Permanent Headcount		71	81	102	103	102	-	100	100	100	100	100	100	0
Agency		5	8	7	2	2	-	0	0	0	0	0	0	0
Total headcount		76	89	109	105	107	-	100	100	100	100	100	100	0

Basis for costs

These cost estimates represent central programme costs only, which are not included in any Route's or other central function's Strategic Plans. The cost estimates have been prepared on a first deployment basis, assuming provision of support for delivery of a programme of 3 ETCS projects in Control Period 6-7 (CP6-7) – 2019-2029 (see indicative deployment plan figure in section 3.2 above).

The profiles of the cost estimates above do not reflect any 'smoothing' effects expected to result from development of an integrated programme (see section 3.1). This integrated approach, which was initiated following completion of the SOBCs, is seeking to optimise the balance of industry-wide activity in the context of recognised affordability and deliverability constraints.

Summary of costs by team or activity within the function

Activity/team	CP6 total (£m)	Comments
Industry programme activities	84	Industry PMO, Rail System Authority subscriptions, support services (including business case and strategy support, technical assurance)
Rail System Authority	7	'Guiding mind', system requirements and integration product development and support, joint development group
National enabling projects	69	Test facilities, £34m (ENIF, RIDC and System Integration Lab) and telecoms upgrades, £35m (core GSM-R network and on line key management)
TM maintenance and support	20	Maintenance and support for traffic management system deployments in Anglia and Wessex Routes
Total	180	

(Accommodation, training and GDR leadership cost held separately within GDR Support.)

The Digital Railway Programme has worked with Routes to agree in principle the balance of responsibilities in a 'thin client' approach and from this has determined the central programme running costs and cost requirement for a digital Rail System Authority shown. The programme is also responsible for national enabling projects including test facilities and telecoms upgrades.

The ultimate CP6 funding requirement will depend on how many schemes are taken forward for development and delivery in CP6 (as discussed in section 3 above). For instance, in a 'NPIF funded only' scenario, where only one TM scheme is funded in CP6, a reduced central programme cost is likely to be needed, since a lower level of industry co-ordination and integration would be required and national enabling activities such as fitment of ETCS to train operators' fleets are likely to be considerably reduced.

Although work to develop future technology (including

ETCS level 3) and new operating methods to deliver further benefits is not being formally commenced yet, a small element of central programme funds in CP5 enables requirements development.

6.2. Route Business Scotland details – Nil return for DRP

6.3. Digital Railway Programme business unit's cost drivers, headwinds and efficiency

This section has not been completed for central programme costs as relevant impacts on costs are likely to be determined best once the number of digital upgrade schemes going forward becomes clear.

6.4. Risk and uncertainty in the CP6 plan

See section 5.3 above for a programme-wide assessment of risk and uncertainty in relation to the full consolidated






programme of digital deployments for CP6. See section 6.1 above for an assessment of uncertainty in relation to the Digital Railway Programme business unit's costs.

6.5. Uncertainty ranges for CP6

The information in the table overleaf, presents the Digital Railway Programme's estimate of the overall range of uncertainty across our expenditure and income for CP6. We have also identified the main drivers of the uncertainty ranges i.e. minor variance relating to number of schemes funded. The information in this table is based on the detailed inputs provided in our opex, renewals and income submissions.

Headwinds/tailwinds and efficiencies/inefficiencies are not included in the spot estimates at this stage in the programme's development.

Spot estimates reflect central scenario (see Appendix D below) and the main scenario of all SOBC deployments going ahead in 2017/18, for completion in CP6/7. High estimates allow for 5% additional central programme resources if scheme support and development requirements are greater than anticipated. Low range reflects 'NPIF funded only' TM deployment throughout South East route where only Rail System Authority and some digital strategic activities will be required.

Area	Potential range (low – spot – high)	Summary of key drivers of the uncertainty range	
		Driver of range	% of range
Industry programme activities	Low (-£71m) Spot (£84m) High (+£4m) 	Number of schemes to be funded	50
		Route capabilities e.g. in business case development, negotiating third party financing and local technical assurance	50
Rail System Authority	Low (-£0m) Spot (£7m) High (+£0m) 	Number and location of schemes to be funded	50
		Volume of deployment activity and likely size of supply chain pool required	25
		Early development stage of some technical production activities	25
TM maintenance and support	Low (-£20m) Spot (£20m) High (+£4m) 	Number, type and location of schemes to be funded	100
National enabling projects	Low (-£69m) Spot (£69m) High (+£1m) 	Number, type and location of schemes to be funded	50
		Early development of some technical development activities	50
Total expenditure	Low (-£160m) Spot (£180m) High (+£9m) 		

7. Sign-off

- This document and accompanying templates are owned by Managing Director, Group Digital Railway.
- Submission of this document indicates confirmation that:
- all appropriate level 1 assurance activities have been undertaken (see separate advice on definition of level 1 assurance);
- the Managing Director, Group Digital Railway is satisfied with the quality, currency and appropriateness of the content of this document as well as the cost, volume and activity projections to which it refers;
- the signatories are satisfied that the plan has been assessed as deliverable, subject to the assumptions articulated in Appendix B.

Authorised by:



David Waboso
Managing Director, Group
Digital Railway

01/02/2018



Michael Reynolds
Finance Director, Group Digital
Railway

01/02/2018



Michael Flynn
Programme Director, Digital
Railway Programme

01/02/2018

Appendix A N/A

Appendix B Key assumptions

See section 4 above

Ref no.	Topic (e.g. dependency, deliverability, climate etc.)	Assumption	Areas of spend impacted (e.g. all opex, single team, all spend etc.)	Is this a change of assumption for CP6?
A002	Affordability	Business cases provide sufficiently compelling evidence to generate investment	All (including Routes' and other central functions' Strategic Plans)	N/A
A003	Deliverability	The Integrated Schedule reflects all schemes currently going through the SOBC process, and the most likely solution options within each scheme. It does not reflect anticipated decisions that will be made during SOBC review and approval, i.e. which schemes or options will be approved and/or prioritised. As such, it does not currently reflect resource constraints –these will be considered following SOBC outcomes.	All (including Routes' and other central functions' Strategic Plans)	N/A
A005	Procurement	Systems requirements and integration programme will have a set of assured requirements to achieve M9 in Q1 2018.	All (including Routes' and other central functions' Strategic Plans)	N/A
A006	Deliverability	Renewals works will be brought forward from the original dates [in brackets] in the integrated schedule to the proposed dates, and are subject to change control	All (including Routes' and other central functions' Strategic Plans)	N/A
A007	Deliverability	Enabling infrastructure programme will finish within proposed delivery windows.	All (including Routes' and other central functions' Strategic Plans)	N/A

Ref no.	Topic (e.g. dependency, deliverability, climate etc.)	Assumption	Areas of spend impacted (e.g. all opex, single team, all spend etc.)	Is this a change of assumption for CP6?
A008	Deliverability	Train fitment dates from the train fitment programme are deliverable, including buy-in from TOCs, FOCs and ROSCOs	All (including Routes' and other central functions' Strategic Plans)	N/A
A009	Affordability	Funding for the renewals works, the enabling infrastructure programme and the train fitment programme will be secured.	All (including Routes' and other central functions' Strategic Plans)	N/A
A010	Procurement	Suppliers will be engaged during the development of Systems requirements and integration, to ensure the deployment readiness (the product update the suppliers need to do to comply with M9).	All (including Routes' and other central functions' Strategic Plans)	N/A

Appendix C N/A

Appendix D Scenario planning

Part (1): Tactical scenario planning for CP5

Provide information on the impacts on CP5 of each of the following scenarios:

- Scenario 1: 20% increase in total remaining expenditure

Details and benefits of additional expenditure in CP5

Area of spend	Yr 4-5 outstanding spend (£m)	Potential investment increase (£m)	Comment on benefits
Development funds to prepare for CP6 deployment	*	*	Addresses key risk, lack of readiness for digital deployment at start of CP6

Rolling stock fitment	*	*	Accelerate fitment of rolling stock to enable subsequent ETCS deployment, maximise opportunities of franchising programme and avoid stranded assets
TM scheme development	*	*	Allows delivery of a wider range of TM schemes at a lower risk because resources could be developed and deployed to enable more robust delivery of a wider range of projects
Total			

* Detailed activity planning for the Digital Railway Programme is subject to funding decisions by the DfT as laid out in their Memorandum of Understanding with Network Rail, to be confirmed through approval of whichever NPIF candidates and Route upgrade schemes are chosen to proceed to further development (as described above in section 3).

Scenario 2: 20% decrease in total remaining expenditure

Details and impacts of reduced expenditure in CP5

Area of saving	Yr 4-5 outstanding spend (£m)	Maximum potential saving (£m)	Comment on impacts/issues
In order to preserve benefits over a wider area of the network, all schemes would be assumed to be slowed because stop/start would increase the overall cost.	*	*	Delay delivery of all schemes for TM and ETCS with some falling into CP7
It would not necessarily be possible to deliver outputs in CP6 without prioritising some of the schemes	*	*	Necessitate prioritisation of schemes to deliver fewer TM schemes in CP6
Stop some central activities e.g. System Authority or PMO, leading to loss of integration or pushing of costs to Routes i.e. generic	*	*	Inefficient

development and specification activities would have to be carried out by multiple Routes			
Enablers such as cab fitment or test facilities would be delayed, so delaying outputs of Route schemes, which would have cost	*	*	Would delay Route schemes which would have cost consequences from reduced integration as well as delay benefits
Total			

* Reduced expenditure would be addressed by any or a blend of the savings areas identified above, balancing cost inefficiencies of stop/start investment with other impacts. The integrated planning process will enable more detailed recommendations for this scenario to be provided, based on DfT’s approval of schemes to proceed, chosen from NPIF candidates and Route digital railway upgrades.

Note that the Digital Railway Programme is assuming extra funding is available in CP5 to develop these schemes already (as described for scenario 1 above) and so these scenarios would be even more extreme if that funding is not made available and would make delivery in CP6 more challenging.

Central Scenario

A central scenario has been created which reduces expenditure in CP5 and CP6 by slightly more than 20%. This assumes only the Traffic Management and ETCS schemes with the best business cases go ahead (namely East Coast Main Line South and South East Route Traffic

Management extension, alongside TRU - see section 3 above for further information on this scenario). The table below presents the financial requirements for this scenario.

It should be noted that the number of schemes and corresponding benefits lost in this scenario relative to the main scenario are disproportionate to the funding reduction, due to the significance of lost economies of scale and learning.

‘NPIF funded only’ Scenario

A ‘NPIF funded only’ scenario has also been created which reduces expenditure in CP5 and CP6 by 85%. This assumes only the best SOBC business case goes ahead, i.e. South East Route Traffic Management extension. The table below presents the financial requirements for this scenario. The lost schemes and benefits in this scenario relative to the optimistic scenario are even more disproportionate to the funding reduction than in the central scenario.

Central Scenario Expenditure (post headwinds and efficiencies in 17/18 market prices), costs include: ETCS and TM on ECML(S) and TM on South East Route

ECML and SE					Development stage:	SOBC	BCR			Kent 22.1 Sussex 46.3
					Expected delivery year	SE 2021-2024 ECML 2021-2026	Appraisal period			SE 30 years ECML 60 years
<u>Summary description</u>										
South East										
Problem Statement: The South East Route currently experiences the highest number of delay minutes of any route. In part from the reactionary delays caused by flat junctions and high volume of traffic operating on the Route, delays are quickly transferred across the network and impact a high number of passengers.										
Scheme: Integrated Traffic Management for the area controlled by Three Bridges ROC, primarily the Brighton Main Line, isolated Traffic Management for the remainder of the route, option for C-DAS										
ECML										
Problem/Opportunity Statement From the end of CP5-CP6 a number of additional train services are planned south of Peterborough, including new Thameslink services and additional long distance high speed services. More train services are planned than there is capacity for, in particular over the two-track section of railway at Welwyn. The Route have estimated this will reduce PPM for long distance services by between 1-2%. For suburban service, including the Moorgate branch, demand is forecast to increase by 62% from 2012 to 2043 and crowding worsen. The signalling on the south of the ECML is due for renewal in CP6, presenting the opportunity to renew with digital technologies.										
Scheme: ETCS Level 2 no signals and interfaced Traffic Management between London King's Cross and Stoke Tunnel including the Moorgate branch and Herford loop and option for C-DAS.										
					Assumed funding source (£m)					
	CP5 (last 3 years)	CP6	CP7 & beyond	Total		CP5	CP6	CP7 & beyond	Total	
Digital Infrastructure	37.6	750.4	648.5	1,436.5	Core Route Budget (OMR)	40.8	194.2	436.9	672.0	
Business Change	2.5	31.3	3.1	36.9	National Productivity Investment Fund	31.9	209.7	0.0	241.6	
Freight National Passenger Operator	0	268.0	67.6	335.6						
OTMs in-cab fitment	14.2	69.1	2.7	86	Sub-Total (assumed core NR funded)	72.7	392.6	436.9	902.2	
Sub-Total (assumed core NR funded)	54.30	1,118.8	721.9	1,895.0	Franchise in-cab fitment	26.2	131.9	7.4	165.5	
Passenger in-cab fitment	28.3	155.0	9.5	192.8	Enhancements (MoU)	0	0	0	0	
Civil Engineering Enhancements	0	0	0	0	TOTAL	98.9	524.5	444.3	1067.7	
TOTAL	82.6	1,273.8	731.4	2,087.8	Unallocated Funding above Route OMR Target	n/a	-749.30	-287.1	-1,020.10	
<u>Scheme benefits[1]</u>										
<u>Quantified output benefits</u>										
SE Delay minute reduction of up to 4% for isolated Traffic Management and 7% of integrated Traffic Management										
ECML Capacity - an additional 4 tph in the three hour peak on the Moorgate branch. Performance- avoids a 1.5% PPM loss on long distance high speed services (ETCS) reduction of delay minutes in the TM geographic scope by up to 5%										

<p><u>Financial benefits (£m CP6)</u></p> <p>TOC revenue benefits: £25.8</p> <p>Reductions in NR OMR: 0.0</p> <p>Net benefits to consumers and private sector: £43.3m</p> <p>TOTAL: £69.1m</p>	<p><u>Financial benefits (£m NPV over 60 years)</u></p> <p>TOC revenue benefits: £761m</p> <p>Reductions in NR OMR: 0.0</p> <p>Net benefits to consumers and private sector: £1511m</p> <p>TOTAL: £2272m</p>
<p><u>Other qualitative benefits</u></p> <p>SE - Enables part of the Safer Trackside Working strategy, providing traffic management protection system in the integrated traffic management areas</p> <p>ECML - Safety - ETCS offers enhanced train protection reducing the risk of SPADs. DR technologies enable the Safer Trackside Working strategy, reducing the risks to track side workers</p> <p>Journey time - potential for journey time opportunities where speed restrictions are in place due to signal sighting or through changes to operational rules</p> <p>Other opportunities - improved customer information, energy savings</p>	
<p><u>Other dependencies</u></p> <p>East Coast Connectivity enhancements</p>	

NPIF funded only Scenario Expenditure (post headwinds and efficiencies in 17/18 market prices), costs include: TM on South East

SE	Development stage:			SOBC	BCR			Kent 22.1 Sussex 46.3		
	Expected delivery year			2021-2024	Appraisal period			30 years		
<p><u>Summary description</u> Problem Statement: The South East Route currently experiences the highest number of delay minutes of any route. In part from the reactionary delays caused by flat junctions and high volume of traffic operating on the Route, delays are quickly transferred across the network and impact a high number of passengers. Scheme: Integrated Traffic Management for the area controlled by Three Bridges ROC, primarily the Brighton Main Line, isolated Traffic Management for the remainder of the route, option for C-DAS (shown in passenger fitment line)</p>										
Implementation cost (£m)					Assumed funding source (£m)					
	CP5 (last 3 years)	CP6	CP7 & beyond	Total		CP5	CP6	CP7 & beyond	Total	
Digital Infrastructure	30.6	198.4	63.8	292.8	Core Route Budget (OMR)	0.0	0.0	-	0.0	
Business Change	1.3	11.3	0.7	13.3	National Productivity Investment Fund	31.9	209.7	-	241.6	
Freight National Passenger Operator	0.0	0.0	0.0	0.0						
OTMs in-cab fitment	0.0	0.0	0.0	0.0						
Sub-Total (assumed core NR funded)	31.9	209.7	64.5	306.1	Sub-Total (assumed core NR funded)	31.9	209.7	-	241.6	
Passenger in-cab fitment	2.0	13.6	2.7	18.3	Franchise in-cab fitment	2.0	13.6	2.7	18.3	
Civil Engineering Enhancements	0.0	0.0	0.0	0.0	Enhancements (MoU)	0.0	0.0	-	0.0	
TOTAL	33.9	223.2	67.2	324.3	TOTAL	33.9	223.2	2.7	259.8	
<u>Scheme benefits[1]</u>										
<u>Quantified output benefits</u>				Unallocated Funding above Route OMR Target		0.0	0.0	-	64.5	-64.5
Delay minute reduction of up to 4% for isolated Traffic Management and 7% of integrated Traffic Management										
<u>Financial benefits (£m CP6)</u> TOC revenue benefits: £11.8				<u>Financial benefits (£m NPV over 60 years)</u> TOC revenue benefits: £209m						

Reductions in NR OMR: 0.0 Net benefits to consumers and private sector: £29.6m TOTAL: £41.1m	Reductions in NR OMR: 0.0 Net benefits to consumers and private sector: £511m TOTAL: £720m
<u>Other qualitative benefits</u> Enables part of the Safer Trackside Working strategy, providing traffic management protection system in the integrated traffic management areas	
<u>Other dependencies</u>	

Part 2: CP6 scenario planning: investment options

This section describes the benefits of additional investment in the function, over an appraisal period of 30 years.

Details and benefits of investment options for CP6

Investment category	Description	Qualitative benefits	Quantitative benefits					
Performance and resilience	TM scheme development	Allows delivery of a wider range of TM schemes at a lower risk because resources could be developed and deployed to enable more robust delivery of a wider range of projects	Circa 5% reduction in delay minutes. There are a range of candidates with Benefit Cost Ratios as follows:					
			Shortlisted Traffic Management schemes	PV of Costs (£m)	PV of Revenue (£m)	PV of Monetised benefits (£m)	Net of PV (£m)	BCR and VfM category
			London North Western – West Coast Main Line South Traffic Management*	55-157	76-121	85-136	99-107	High (3.7) – Financially positive
			Wessex Route Traffic Management	177	94	240	157	High (2.9)
			Anglia Route Traffic Management	199	79	176	56	Medium (1.5)
Capacity	Moorgate ETCS	Headway reduction to enable frequency	Enables 2 morning peak hour trains to address forecast crowding. This option has a Benefit Cost Ratio of 2.8.					

		increase to address forecast crowding in the morning peak on the Moorgate services	PV of Costs (£m)	PV of Revenue (£m)	PV of Monetised benefits (£m)	Net of PV (£m)	BCR and VfM category
			46	10	102	66	2.8 High
Safety	Rolling stock fitment, Investment in a skills academy	Accelerate fitment of rolling stock to enable subsequent ETCS deployment – potentially earlier benefit realisation; contributes to Automatic Train Protection and Safer Track Worker programmes	These benefits have not been quantified but would support the quantified benefits above.				
Asset life cycle/ obsolescence	Rolling stock fitment, investment in a skills academy – supports schemes for CP6 proposed in LNE, SE, and Anglia. Development of further schemes for	Accelerate fitment of rolling stock to enable subsequent ETCS deployment supports Rolling stock and skills investment underpin using this technology as an option for asset life renewal	These benefits have not been quantified but would support the quantified benefits above.				

	deployment in CP7 and beyond.		
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Detailed activity planning for the Digital Railway Programme is subject to funding decisions by the DfT as laid out in their Memorandum of Understanding with Network Rail, to be confirmed through approval of whichever NPIF candidates and Route digital railway upgrade schemes are chosen to proceed to further development (as described above in section 3).

Other parts of the network where additional digital upgrades are being considered for business case development include Northern Hub, Cumbrian line, Wessex, Feltham, Chilterns, Merseyrail, Manchester Piccadilly and in association with Crossrail 2. No costs are included in this plan for any of these potential candidates.

Appendix E N/A

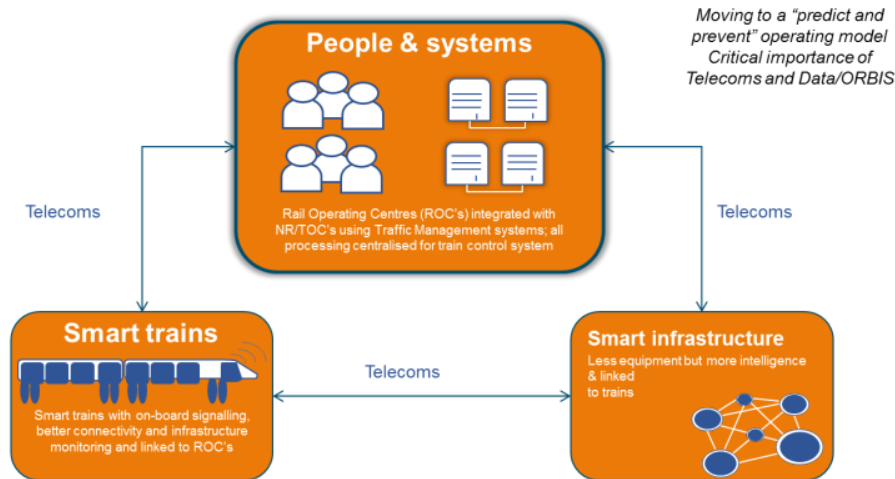
Appendix F N/A

Appendix G Proven digital technologies to deliver NR's vision

Digital Railway is an essential enabler for Network Rail's vision for the future Railway Operating Model.

Figure 13:

The Vision for the Future Railway Operating Model



This approach will deliver a wide range of benefits for passengers and freight by the end of CP7:

- Higher capacity (mass transit, punctuality, reliability and performance)
- Through Digital Railway, fundamentally change the nature of the roles within the industry and consequential review of the current franchising model
- Increased flexibility

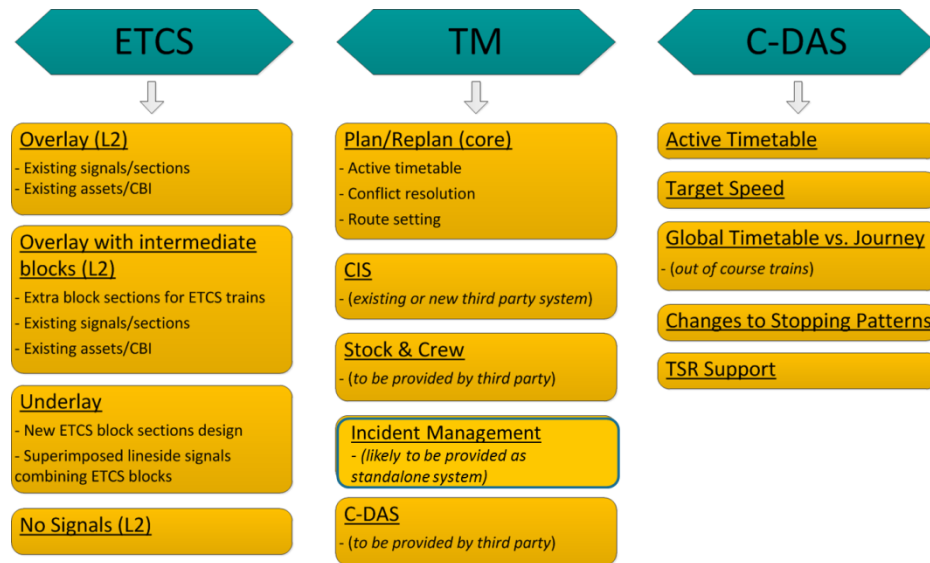
- Improved performance and recovery
- Lower whole life cost
- Opportunities for third party investment and financing
- Better connectivity
- New ways of working by operations and maintenance staff
- A consistent Operation Concept across the network

To support this vision, Digital Railway is developing requirements to align with the emerging maintenance strategy that will underpin the future Railway Operating Model. The programme's requirements include:

- reducing whole life cost of ownership;
- achieving improved levels of reliability and availability;
- protecting and, where possible, improving the safety of personnel involved in asset maintenance;
- avoiding unnecessary maintenance without compromising asset performance or life expectancy;
- capture and assessment of asset condition and performance data to support the continual development of asset knowledge and optimised interventions; and
- developing, where practicable, enhanced asset condition monitoring and analytics to predict (and prevent) asset failure.

Proven digital technologies that are ready for deployment today are described below, including those elements for deployment by the wider industry beyond Network Rail.

Figure 14: Proven technologies that can be deployed today



ETCS (European Train Control System)

ETCS is an automatic train protection system, based on cab signalling and track to train data transmission. It ensures trains operate safely at all times in providing safe movement authority directly to the driver through the in cab display, can apply the brakes in the event of a Signal Passed At Danger (i.e. Red) or over speed as it continuously monitor the driver's actions. There are a number of different variants of ETCS described in Figure 14.

Traffic Management

Traffic Management is an operational control and management information system, capable of providing real-time information to passenger and freight customers. The system allows prediction of conflicts and enables real-time timetabling and re-planning as required. The Plan / Re-plan system is an integral part of the Traffic Management System and is the core functionality provided by TM. In full automatic mode, amendments to train services can be made by manipulating the train plan using the Plan and Re-plan system. Reference to Traffic Management in this document

refers to the core Plan and Re-Plan system.

There are three variants of Traffic Management:

- **Isolated:** The system advises the operator of changes required to the existing timetable, alternative routing actions are implemented by the signaller.
- **Interfaced:** Plan / Replan system interfaces to an existing control system. The system automatically request routes to be set following suggested conflict resolution by the planning system.
- **Integrated:** The Plan / Re-plan system is directly interfaced to the Interlockings along the line and can set routes as required for each train. This allows functionality such as flexible areas of control, enabling ROCs to flex workload to current conditions.

The real time train information can be shared with a number of other applications / decision support tools. These systems can be standalone or interface to the Traffic Management System:

Table 6: Decision support tools

Decision Support Tool	Description
Stock and Crew	Used in real time to ensure that the right resources are in the right place at the right time. It combines data from the train service and its actual running diagram and resource information and their associated rolling stock allocations and crew rosters. Largely a non-NR cost as this tool is for train operators to deploy.
Incident Management	Helps reduce the impact an incident has on the rail network across the whole incident lifecycle. The biggest delay minute saving that the IMS will have relates to the initial period of an incident and improving the time taken to get required resources to site. This is achieved by faster identification of

	incident location, faster access to supporting data and better communication. Largely a NR-only cost.
Customer Information System	Uses operational information taken from other railway systems and converts into a format that is easily understood by customers. CIS feeds information that is displayed on the electronic arrival and departure screens and displays that can be found on platforms. Largely a non-NR cost as this tool is for train operators to deploy.
C-DAS	A Connected version of DAS (Driver Advisory System). DAS is an existing system which optimises driving techniques, helps manage capacity/performance, improves energy consumption and reduces carbon emissions. Largely a non-NR cost as this tool is for train operators to deploy.

Enabling telecommunications activities include

- design and implementation of works for both new Global System for Mobile Communications-Railway (GSM-R) base-stations (infills) and upgrades to existing GSM-R base-stations;
- design and implementation of works for both new Fixed Telecommunication Network (FTNx) infrastructure and modifications to existing.

Supporting data management services include data acquisition, validation, storage, processing, management, change control, analysis and provision of all system requirements for implementation and operation of the Digital Railway.

The role of the Digital Railway Programme is to provide common interface specification for Traffic Management and the decision support tools.

Automatic Train Operation (ATO)

ATO is a system that performs automatic driving of the train to meet the (real time) operational timetable in the most energy efficient way. It has many of the same benefits as C-DAS but is able to provide significant performance improvements because the movement of the train is now automated. ATO must be deployed with ETCS.

Telecommunications and data management

There are a number of key enabling activities to support the technologies described above, chiefly telecommunications and data management upgrades.