Long Term Passenger Rolling Stock Strategy for the Rail Industry

Fourth Edition, March 2016

EVERSHOLT RAIL GROUP

angel Trains

porterbrook

Rail Delivery Group

This Long Term Passenger Rolling Stock Strategy has been produced by a Steering Group comprising senior representatives of:

- Abellio
- Angel Trains
- Arriva
- Eversholt Rail Group
- First Group
- Go-Ahead Group
- Keolis
- National Express
- Network Rail
- Porterbrook Leasing
- Rail Delivery Group Executive Team
- Stagecoach

Cover Photos:
A BR-procured Virgin Trains East Coast Type F IC225 train of 1989; a Siemens FTPE Type B Class 185 DMU introduced in 2005; and a Vossloh ScotRail Type B Class 68 locomotive introduced in 2012

Foreword by Claire Perry MP, Parliamentary Under Secretary of State for Transport

I would like to thank the rail industry for this further update of the Long Term Passenger Rolling Stock Strategy. It continues to be a most useful source of information at a time of great change in the rail industry. It also has an important role to play in supporting the Government's major investments in projects such as Thameslink, Crossrail, electrification, the Northern Powerhouse and HS2. Improvements in rolling stock are part of the Government's investment in the railways in the largest modernisation since Victorian times that will deliver better journeys for passengers.

I welcome the way in which private sector train companies and vehicle owners work in partnership with the Department to deliver for passengers. This partnership is producing innovative plans to expand and update our train fleets to meet the unprecedented growth in passenger numbers.

But it is not just about capacity: the quality of the journey is crucial as well. Passengers will see their travelling experience enhanced by the introduction of new trains and the refurbishment of existing fleets. Provision of free WiFi and up-to-date train interiors compliant with disability standards are some of the improvements that the Government welcomes. I look forward to the industry continuing to work to drive such improvements.

Technological innovation is continually delivering new solutions for rail users. The Government endorses the need to continue to make use of it to improve information to passengers as well as exploiting less visible technologies to increase network capacity and reduce energy consumption.

Having a skilled workforce is essential if the industry is to deliver the upgrades we want to see over the next decade. The Department strongly supports plans laid out in the Transport Infrastructure Skills Strategy to attract the best talent to the industry and to create 20,000 new apprenticeships that it needs.

I am also very pleased that the Rail Supply Group has produced its first industry strategy, 'Fast Track to the Future'. Investing in people and skills and accelerating innovation is important if the UK is to support and grow its domestic and international markets. The world's rail supply industry will shortly be meeting at the InnoTrans exhibition in Berlin where the 130,000 attendees from all over the world will get to see the excellent work that that UK firms are doing. I am very pleased to see so many UK firms so active in the domestic rolling stock supply chain, whether it be supporting Hitachi's new intercity express train plant in the North East or working on rolling stock refurbishment and life-extension projects in the East Midlands and Yorkshire.

The Long Term Passenger Rolling Stock Strategy will continue to have an important part to play in delivering the 21st century rolling stock that rail users deserve. This document sets out a path to improved reliability, greater capacity, and a better experience for passengers and I look forward to seeing those benefits come to pass.

Claire Perry MP

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Bombardier London Midland Type B Class 172 'Turbostar' DMUs introduced in 2009

Executive Summary

This is the fourth annual edition of the Long Term Passenger Rolling Stock Strategy (RSS). Like its predecessors it sets out a range of forecasts for the likely size and mix of the national rolling stock fleet to accommodate future passenger numbers over 30 years. It is fully consistent with the rail industry's Long Term Planning Process, which also uses a timeframe of 30 years. The RSS has become part of a broader landscape of initiatives in the rail sector, such as the Rail Supply Group's sector strategy, to provide the rail industry and its supply chain and investors with a longer term view of likely demand.

Each edition of the RSS has included 10-year forecasts of the size and composition of the national passenger fleet. The associated forecasts for the number of new vehicles required have been revised upwards with each annual update of the RSS as additional commitments have been made by TOCs, surpassing previous expectations. The total number of new vehicles committed for delivery in the five-year period that commenced in April 2014 (Control Period 5, CP5) and in the early years of CP6 (2019 to 2024) is now over 4,500, with a capital cost of more than £7.5 billion. Around 50% of these new vehicles will be built in Britain. The average age of the national fleet is estimated to fall from 21 years to 16 years over this period.

A major change in this edition has been the re-scheduling of Network Rail's commitments to electrification in CP5 and CP6, following the Hendy Review. The total net increase in fleet size had already been forecast to be lower in CP6 than in CP5, following completion of the very large orders for the Thameslink, Crossrail and Super Express Train (IEP) projects. The slower pace of the electrification programme will result in an increase in the number of new diesel and bi-mode vehicles, but further orders for new electric vehicles in CP6 will result from electrification and refranchising in CP5 and CP6.

The size of the market for new trains for the UK railway is attracting interest from train builders and new sources of finance, and there is now welcome evidence of additional capacity not only to build but to finance the projected growth in the UK rolling stock fleet. The market in rolling stock procurement also appears to delivering real reductions in the capital cost and finance cost of new trains. This will be important to support the forecast levels of rolling stock required in an affordable way for the Government and the taxpayer. There will always be an optimal age for the overall UK rolling stock fleet to provide value for money for assets with long economic lives. Significant investment will be required to deliver additional functionality or to enhance the customer environment for existing fleets, as instigated by fleet owners, their customers, or the franchising authorities.

The longer term conclusions are largely unchanged, proving to be stable over four annual editions in spite of changes in forecasting methodology and external factors. The total national passenger fleet is forecast to grow by between 51% in the 'Low' scenario and 99% in the 'High' scenario over the next 30 years, while the proportion of vehicles that will use electric traction is forecast to rise from 70% today to over 90% by 2034 in all scenarios. The analysis indicates that between 13,000 and 20,000 new electric vehicles and up to 1,900 new non-electric vehicles will be required over the 30 years to 2045. The strategy emphasises the resulting benefits to passengers and the wider community, including improvements to capacity, punctuality, reliability, passenger facilities and the environment.

A. Introduction – Goals and Scope

1. This is the fourth annual edition of the Long Term Passenger Rolling Stock Strategy (RSS). It represents a collaborative, industry-led strategy for passenger rolling stock. The work is led and funded by a Steering Group (RSSSG) comprising senior representatives of the Rail Delivery Group (RDG, including Train Operating Company (TOC) Owner Groups and Network Rail) and the three principal rolling stock owners (ROSCOs). RSSSG is co-chaired by Malcolm Brown, CEO of Angel Trains, and Andrew Chivers, Managing Director, Rail, National Express. Joint meetings are held between RSSSG and senior members of the Department for Transport (DfT) Rail Group.

2. The need for a high-level, long term RSS as a way of helping to forecast future requirements for fleet size and composition was originally articulated by the Association of Train Operating Companies (ATOC) in its discussion paper 'Rolling Stock and Value for Money' published in December 2011. That paper was welcomed in the March 2012 Government Command Paper 'Reforming our Railways'. Among the recommendations of the Command Paper were that development of a long term RSS would help shape expectations, giving more visibility to the supply chain, and thereby achieving long term, whole-system benefits. DfT described the third edition of the RSS as "this is the kind of leadership that the Rail Executive is looking for from the rail industry as the market continues to mature."('Rolling Stock Perspective', DfT, June 2015).

3. The fundamental aim of the RSS is unchanged from the first edition, as follows:

> Set out the dimensions of industry-wide rolling stock requirements over a 30-year horizon in the context of growth, committed and likely network developments and the direction of government policy, without imposing constraints on the market to deliver appropriate solutions.
>
> A key objective of the Strategy must be to promote better value for money from the rail industry. The Strategy should therefore as a minimum indicate the manner in which it might reduce not only rolling stock unit costs and wider industry costs, but also increase train capacity, route capacity and industry revenues.

4. The RSS is intended to add value by:
   - facilitating a whole-system approach to strategy, bringing together demand growth, infrastructure, train services and fleet scenarios;
   - providing a backdrop for and an input to longer term planning, by train builders, ROSCOs, TOCs, Network Rail, and their suppliers and funders;
   - identifying opportunities to smooth peaks and troughs of workload;
   - highlighting priorities for improving Value for Money (VfM); and
   - identifying and analysing issues of concern for the short, medium and long term.

5. Fleet size forecasts from the RSS have been used by the Rail Supply Group (RSG) as an input to its rail industry sector strategy, published in February 2016 as 'Fast Track to the Future'. The forecasts are viewed by the supply chain as a critical part of providing greater visibility of potential investments. The forecasts have also been used by the National Skills Academy for Rail (NSAR) to analyse future manpower requirements for apprenticeships and for the design, manufacture, modification and maintenance of railway rolling stock. This analysis has in turn been used by the Government to inform the Transport Infrastructure Skills Strategy, published in January 2016, and by investors to inform rolling stock investment decisions.

6. For each annual iteration, the emerging work has been discussed with the train builders that are members of the Railway Industry Association (RIA). RIA, the train builders and their suppliers have welcomed the creation of the RSS and its annual updates. The RSS is fully consistent with the industry's Long Term Planning Process (LTPP).

7. This fourth edition of the RSS has been developed in parallel with and has provided inputs to the rolling stock, depot and stabling, and environmental components of the LTPP for Control Period CP6 (2019 to 2024), and specifically for the Initial Industry Plans (IIPs) being prepared by the rail industry. It is currently assumed that, similarly to the arrangements for CP5, this will be developed further for:
   - The Rail Investment Strategies (that are expected to replace the previous High Level Output Specifications (HLOSs), in June 2017); and
   - The Industry Strategic Business Plans (ISBPs, January 2018).

8. RSSSG has set out the key principles which should apply with regard to the provision of rolling stock. Alongside government's important role in setting out the strategic direction and the desired outcomes, these are that:
   - the franchising model is an excellent mechanism to deliver value for money rolling stock provision;
   - rolling stock provision should be the result of market-driven solutions, procured in a competitive environment; and
   - the whole-life, whole-system costs and benefits of rolling stock must be optimised.

9. As it has evolved through its annual revisions, the RSS has taken and will take account of:
   - changes to the franchising programme;
   - new franchise commitments, noting the impact of the credit now being given in the evaluation of franchise bids for quality to be delivered by train operating franchises;
   - the continuing high levels of growth in peak period and all-day passenger demand;
   - the Market Studies and Route Studies published by Network Rail since 2013;
   - the Rail Industry Sustainable Development Principles; and
   - the Hendy Report and Bowe Report into Network Rail's enhancements programme, and the Shaw Report into the future shape and financing of Network Rail.

10. At an early stage, RSSSG expressed concern that franchises could become heavily shaped by the large centrally-procured contracts for the trains for the Intercity Express Programme (IEP) and the Thameslink project respectively; and that the scope for adopting the principles of paragraph 8 above might be further curtailed by the DfT's need to negotiate Single Tender Actions (STAs) with some existing franchisees, and limitations on the DfT's operating expenditure budget. We recognised the short term pressures faced by the DfT, but stated that we believed that the principles of our approach still held true and that it was important to mitigate the risks which those pressures might pose to securing long term value for money.

11. In particular, we stated that care must be taken that:
   - guidance from DfT should not be interpreted as, and should not become (however inadvertently), the specification of inputs;
   - short term savings in rolling stock costs to meet the DfT's budget constraints should not be made at the expense of whole-life, whole-system value;
   - the need for short term action should not constrain competitive tension and innovation;
   - 'de-confliction' clauses in franchise ITTs (where bidders may have some of their rolling stock options reduced because of potential conflict with parties bidding for another franchise at the same time) should not result in significant distortion of the market for rolling stock.

B. Principal Changes Incorporated in this Fourth Edition of the RSS

12. Our forecasts contained in Section H on page 18 of the quantities of new rolling stock to be delivered in CP5 and CP6 have been significantly increased by the confirmation of orders for new trains for the Great Western, Northern and TransPennine Express (TPE) franchises, in addition to those previously announced for the Essex Thameside, Thameslink (including for Gatwick Express and Moorgate services), ScotRail, Caledonian Sleepers and South West Trains (SWT) franchises, and the London Overground concession. Evidence has emerged of some reductions in the costs of building and financing new rolling stock. Competition appears to have been a factor, prices also benefitting from the sunk development costs for the new fleets.

13. The increased emphasis on credit being given by franchising authorities for quality to be delivered by franchises and concessions, which RSSSG totally supports, together with the commitments for new bi-mode and diesel trains for the new Northern and TPE franchises have now to some extent mitigated the previous concerns about shortages of rolling stock able to operate away from the electrified routes. This is evidence that the market is able to devise innovative solutions. The competitions for the Northern and TPE franchises both had to take account of the uncertainty over timescales for electrification of key routes in the North West and North East of England. The published letter from the Secretary of State to the DfT Permanent Secretary dated 26 February 2015 regarding additional new build vehicles for the Northern franchise refers directly to these issues. It stated “The railways need a long term solution that will secure the continued provision of services on lines that are never likely to be electrified. I note that the latest forecasts predict a shortfall in diesel vehicles in the coming decades”.

14. The forecasts for the future size and composition of the passenger fleets have been comprehensively updated and rolled forward to 2045. RSSSG has also updated the electrification scenarios to be consistent with the Hendy Report. The long term conclusions about the total size of the national fleet are largely unchanged, but there have been some changes to the composition of the national fleet in CP6 and subsequent Control Periods as a result of changed assumptions about the pace of future railway electrification.

15. Significant changes or refinements have been made to the following sections of the RSS, to reflect changes in assumptions or in response to stakeholder requests:
    - Section D, methodology for the forecasting of fleet sizes;
    - Section E, assumptions for future electrification;
    - Sections F, G and H, implications for future fleet size and composition, in particular for new rolling stock and rolling stock capable of operation beyond the electrified routes;
    - Section I, an expanded section on passenger requirements and benefits;
    - Section K, new material on sustainability and technology;
    - Section M, an updated section on value for money issues and initiatives;
    - Appendices 1 to 3 and 5, updated data on the timescales for new fleet deliveries, electrification and other infrastructure enhancements, and the franchising programme.

C. The Approach Adopted for the Strategy

16. As in the previous editions, scenarios for fleet size have been modelled by five-yearly Control Period for the whole of the 'main line' passenger fleet including England, Wales and Scotland, London Overground, Crossrail and HS2 but excluding vehicles off-lease, and also excluding London Underground (LUL), light rail, tram-train, charter and international fleets.

17. Each of the existing fleets has been categorised by one of seven generic types of train:
    A. Shorter Distance Self-Powered (diesel, generally with 75 mph maximum speed);
    B. Middle Distance Self-Powered (diesel, with 90/ 100 mph capability);
    C. Long Distance Self-Powered (diesel, with 100/ 110/ 125 mph capability);
    D. Shorter Distance Electric (generally with 75 mph maximum speed);
    E. Middle Distance Electric (with 90/ 100/ 110 mph capability. Some future trains may require 125 mph capability);
    F. Long Distance Electric (with 100/ 110/ 125/ 140 mph capability); and
    G. Very High Speed Electric (140 mph and above, for domestic services on HS1 and HS2).

18. In response to requests, information about which of the existing fleets have been categorised in each of these seven categories is contained in Appendix 4. Individual class numbers have not been used in the analysis of future fleet sizes beyond CP5. The RSS is not a 'cascade plan' for the deployment of rolling stock, nor is it in any way prescriptive. Consistent with RSSSG's support for market-based approaches, it is not intended to constrain TOCs and funders from making the best possible decisions about rolling stock procurement, maintenance, enhancement, life extension and replacement based on thorough business case analysis.

19. To develop these scenarios, RSSSG initially used forecasts for growth in peak period passenger demand contained in the Route Utilisation Strategies (RUSs) published by Network Rail in 2011. As outlined in Section D on page 7, we have subsequently and comprehensively updated our projections to be consistent with the forecasts of peak period (and in some relevant cases all-day) passenger demand over ten years and 30 years as included in the Market Studies and Route Studies published by Network Rail since 2013.

20. Using these inputs, three composite scenarios were defined and modelled as follows.
    - 'Low' - Low growth combined with a relatively low level of future electrification.
    - 'Medium' - Medium growth combined with a medium level of future electrification.
    - 'High' - High growth combined with a higher level of future electrification.

21. At the heart of the RSS, and facilitating its future updating, is a spreadsheet model. The Market Study-based peak period passenger demand forecasts for growth and the selected electrification scenarios are route-specific, and these have been used to provide bottom-up inputs to the spreadsheet model using the existing franchise map for convenience (with the addition of Crossrail and HS2). For each TOC, the total fleet size was then determined for each of the three composite scenarios at the end of CP5 (2019), the end of CP6 (2024) and in the year 2045. The implications for the end of CP7 and for the end of CP8 have then been determined by a process of interpolation, taking account of any date-specific assumptions.

22. These forecasts and scenarios for long term peak period passenger demand growth and electrification cannot, of course, quantify unpredictable external factors (e.g. the economy), or for future government policy (e.g. in relation to fares policy, investment in rail infrastructure, road pricing, etc). The RSS has taken account of such uncertainties by developing the three composite scenarios and by treating the RSS as a living entity. As is demonstrated by the fact that this is now the fourth annual edition of the RSS, the intention is that RSSSG will continue to update the RSS annually to reflect industry and external developments including the franchising programme and emerging government policy.

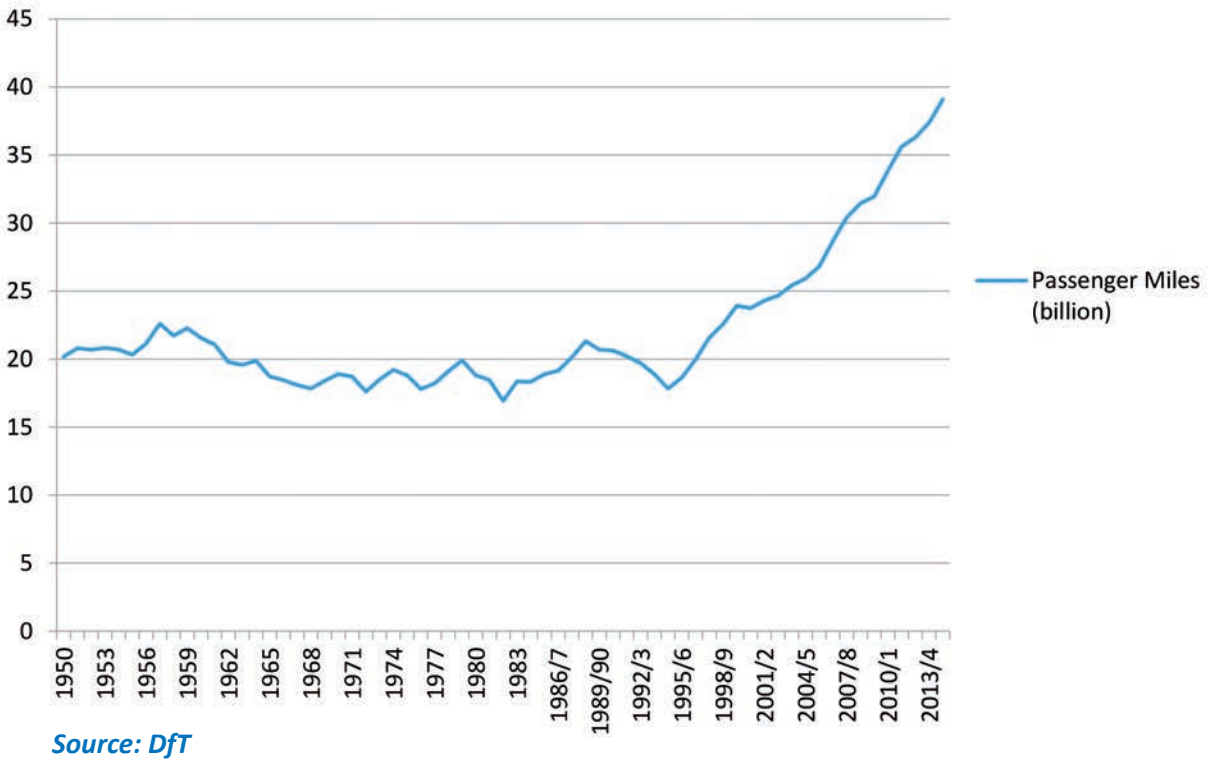
23. The original RUSs contained, and the new Route Studies are updating, many route-specific infrastructure and timetable options for increasing capacity beyond CP5. Some of the presently committed enhancements including the IEP, main line electrification, Thameslink, Crossrail and HS2 projects will provide additional capacity well beyond these timescales. On many routes it will be possible to lengthen trains or run more trains within the existing infrastructure. On others, schemes considered in the Route Studies will be needed to provide sufficient paths, station capacity, depots and rolling stock stabling capacity. The costs and benefits of many of these schemes have not yet been established. The LTPP will address these issues progressively, route by route, repeated and updated on a five-year cycle. Train operators, ROSCOs and Network Rail work through these processes to identify good value for money outcomes and to develop an overall rail development strategy, mindful of the need to improve industry efficiency and to reduce total levels of subsidy.

CAF/ Siemens Heathrow Express Type E Class 332 EMUs introduced in 1997

D. Planning for Growth – Sources of the Assumptions Adopted

24. Total passenger miles grew by 110% in the 20 years between 1995/6 and 2014/15, an average compound rate per year of 3.8%. (Source: ORR data). Even in the six years of lower economic growth after 2007, the average annual growth in passenger miles was 3.5%, significantly out-performing other transport modes in Great Britain and other railways in Western Europe. This sustained rate of growth is illustrated in Figure 1. There was no other period of such sustained growth of rail passenger demand in Britain in the 20th century, and this is to some extent higher than can be explained using the industry's standard passenger demand forecasting methodologies.

Figure 1 - National Rail Passenger Miles per Year since 1950



Source: DfT

25. Various studies have attempted to determine why this unprecedented period of sustained growth (including through the recent recession), had not been predicted. It appears that this is the result of a combination of:
    - Changes in the external environment (e.g. population, housing and labour market factors);
    - Changes affecting competing modes (e.g. declining ownership and use of cars by younger males);
    - Initiatives and improvements introduced by the rail sector.

26. The changes in the rail sector have included:
    - Financial incentives on TOCs to grow their businesses;
    - Access to private sector capital;
    - Frequency, journey time and rolling stock quality improvements;
    - Cost and time-savings of advance purchase fares and smart cards;
    - Technology enabling rail passengers to make better use of on-train time;
    - Improved revenue protection;
    - Expansion of station car parks;
    - Other smaller-scale improvements to the attractiveness of rail.

27. National rail passenger revenue has more than doubled in real terms from £4.0 billion to £8.9 billion between 1995/6 and 2014/15 (at 2014/15 price levels, source: ORR revenue data and ONS RPI data). The average fare paid per passenger mile has risen by only 5% in real terms over this 20-year period. The gross revenue received has helped to pay for the very substantial investment programme that the industry is undertaking in CP5. The same opportunity exists in future to help pay for further growth in capacity, in a sustainable manner.

28. To assess the implications for the number of vehicles needed in the future, we examined the relationship between demand and passenger fleet size. The 110% increase in passenger-miles in the 20 years between 1995/6 and 2014/15 was achieved with an increase of just 15% in the size of the total national passenger fleet. This major increase in fleet utilisation efficiency since 1995 was principally achieved by much improved marketing and utilisation of spare off-peak capacity. In addition, changes have been made to the type, configuration and functionality of much of the national fleet. These have increased the average capacity per vehicle. Examples have included:
    - Replacement of Mark 1 electric multiple units (EMUs) and diesel multiple units (DMUs) and Mark 2 coaching stock with sliding-door vehicles, which provided more capacity for peak period passengers;
    - Introduction of trains with metro-style interiors for some inner suburban services south of the River Thames, and on the London Overground;
    - Elimination of most locomotives and non-passenger carrying vehicles for the Virgin West Coast and CrossCountry TOCs (meaning that more of the train is available for carrying passengers);
    - Changes to seating configuration including conversion of some first class accommodation to standard class;
    - Achievement of higher levels of fleet availability, and of higher average train speeds on some routes; and
    - Introduction of automatic passenger load weighing and counting technology on many fleets (which has led to more efficient utilisation of rolling stock).

29. In spite of these factors, peak period crowding has become a problem on many routes. This has led to the major programmes of investment in infrastructure and rolling stock which are now coming to fruition in CP5.

30. The three Network Rail Market Studies, for the London & South East (L&SE), Long-Distance and Regional Urban markets respectively, underpin the LTPP. The peak period passenger demand forecasts contained in the Market Studies form a key input to the twelve Route Studies now being published by Network Rail, of which seven are now available at least in draft form.

31. The Market Studies are more useful than the RUSs in that:
    - they provide forecasts of peak passenger demand by main route and for the principal regional cities in 2023 and 2043, whereas the previous 2011 RUS documents covered a period of around 20 years only; and
    - they incorporate four alternative composite long term demand scenarios comprising a wide range of macro-economic and micro-economic factors, demographics, 'consumer tastes', and 'the supply of travel opportunities'.

32. The forecasting methodology adopted for the RUSs, Market Studies and Route Studies focuses primarily on route-specific peak period passenger volumes and peak capacity, since that is what determines strategic level planning of railway infrastructure, rolling stock and timetables. Peak period passenger demand has risen more slowly than off-peak passenger demand, but is nevertheless significant. For example, in the last three years, morning peak TOC passenger numbers into London have increased at a compound rate of 1.8% per year, while the average for ten regional cities in England and Wales has been 2.9% per year. (Source: DfT data).

33. For this fourth edition of the RSS the fleet size growth forecasts have been re-based in order to use route-specific or city-specific passenger growth forecasts from the Market Studies, supplemented where necessary by forecasts contained in the Route Studies. Low, Medium and High growth forecasts for the RSS have for the first time been derived from the four Market Study scenarios, adopting their associated overall range of growth, while retaining the methodology of the previous editions of the RSS. In the case of peak flows to and from London, this methodology takes account of present levels of peak crowding, these being generally rather higher than for the regional cities (source: DfT data). The range of growth forecasts drives a range of possible requirements for future rolling stock capacity.

34. Growth in peak period demand of higher than the High growth scenarios may occur, as many of the additional (presently uncommitted) future route enhancements or service enhancements will themselves produce additional peak period growth requiring fleet growth. Conversely, the franchise bidding process can unlock opportunities to improve capacity utilisation further (for example through improvements in timetable design, fleet availability or fleet utilisation). This can be facilitated by flexibility in franchise specifications and change mechanisms in franchise contracts, and by TOCs continuing to adopt and improve the range of ideas listed in paragraph 28 above. The easiest of such opportunities have already been implemented, but more can be achieved through the effective specification and management of franchises.

35. The Market Studies include forecasts for peak passenger demand growth for all of the principal routes to London, for nine regional cities in England and Wales, and for all-day flows between pairs of 12 British cities. Forecasts for Scotland have been taken from the draft Scotland Route Study. The Market Studies have also provided a 10-year focus on future fleet sizes, as described in Sections G and H on pages 15 to 20.

36. This 10-year focus has been strengthened further in this fourth edition of the RSS. Fleet size estimates have been developed as follows:

    A. Fleet size forecasts to the end of CP6 for some TOCs are largely determined by existing or recently negotiated commitments from franchisees or TfL. TOCs in this category comprise Caledonian Sleepers, c2c, Crossrail, Virgin Trains East Coast, Great Western Railway, GoVia Thameslink Railway (GTR), London Overground, Arriva Rail North (ARN), ScotRail, SWT and FTPE.

    B. Fleet size forecasts to the end of CP6 for a second group of TOCs have been based on forecasts for growth taken from the Market Studies. TOCs in this category comprise Chiltern, CrossCountry, Merseyrail, SouthEastern, and London Midland.

    C. Fleet size forecasts to the end of CP6 for the remaining TOCs are to some extent speculative at present, as these TOCs are currently (or shortly will be) affected by electrification, re-franchising, or open access issues. As with the TOCs in category B, the forecasts are (except for the open access TOCs) based on forecasts for growth taken from the Market Studies, but these will be updated when actual franchise commitments are known. TOCs in this category comprise Arriva Trains Wales (ATW), East Midlands, East Anglia, West Coast and the open access TOCs.

37. We have also included estimates of fleet requirements for HS2 based on the latest available information from HS2 Ltd (including the proposed earlier completion to Crewe) and discussions with them about options for growth after initial service introduction.

E. Electrification – Prioritisation and Analysis

38. As outlined in this RSS, electrification offers major new opportunities to reduce unit costs of rolling stock operation and to provide additional capacity, reliability and environmental benefits as the network progressively shifts from relying heavily on diesel trains on many of the nation's principal long-distance and commuter routes to one in which diesels are increasingly used only on the more lightly used secondary routes.

39. The present total national Network Rail track mileage is 19,337 track miles (as distinct from route miles, and excluding depots and sidings, referred to in this RSS as 'single track miles' (STMs) - source Network Rail Annual Return 2015). Of this, 8,099 STMs (42%) are electrified and 11,239 STMs (58%) are non-electrified. 91 STMs of new electrification were completed in 2014/15, in the North West of England and in Scotland. In the whole of CP4 there were 204 STMs of new electrification.

40. In the third edition of the RSS we reported that the electrification programme authorised in the CP5 HLOS amounted to some 1,850 track miles of electrification. The completion of this programme would increase to 51% the proportion of total track mileage that is electrified. Network Rail subsequently announced that it would be unable to complete this programme, and its other enhancements, within the budget and completion dates previously determined. The revised completion dates for all of the committed electrification schemes in CP5 and CP6 are shown in the Timelines contained in Appendices 1 to 3, based on the report by Sir Peter Hendy published in November 2015, and clarified further in Network Rail's revised CP5 Enhancements Delivery Plan published in January 2016.

41. The DfT has not yet committed to a rolling programme of electrification beyond that included in the Hendy Report, but the direction of government policy is to continue such a programme into CP7 and beyond, provided that a sound business case and affordability can be demonstrated. Views were sought by the DfT on this in response to the 2012 HLOS. Separately an Electrification Task Force, led by MPs and Rail North with advice from Network Rail, presented the case for further electrification in the North of England, in a report published in March 2015. Transport Scotland's CP5 HLOS contained a specific objective of a rolling programme of electrification amounting to approximately 60 STMs per annum, following the completion of the Edinburgh to Glasgow Improvements Programme (EGIP) electrification, the latter including the lines to Stirling, Dunblane and Alloa.

42. The Electrification RUS published by Network Rail in 2009 listed route sections that were considered to be candidates for future electrification. Each route was rated by Network Rail in the RUS in relation to four separate criteria:

    A. Facilitating efficient operation of passenger services;
    B. Facilitating efficient operation of freight services;
    C. Providing diversionary routes for electric trains; and
    D. Facilitating new electrified passenger services.

43. For ranking in terms of ability to facilitate efficient operation of passenger services, Network Rail calculated a metric for each route section of the total number of annual passenger vehicle-miles which might be converted from diesel to electric operation, divided by the number of track miles requiring electrification in that route section (with a higher number indicating a probable better case in that the cost of electrification does not greatly increase with usage of the route). This metric has again been used for the updated Electrification RUS, expected to be published in 2016. Some of the associated analysis has been provided to RSSSG for incorporation in this fourth edition of the RSS.

44. Beyond this baseline referred to above, the updated Electrification RUS is expected to identify four principal electrification options and two further options, together comprising around 1,140 STM. These are the schemes demonstrating the highest value for money. A further 16 schemes totalling nearly 1,900 STM have been appraised in detail but are not recommended for further development at this stage. The RUS does however acknowledge the development of alternative forms of electrification (including bi-mode, battery-assisted or other novel forms of electric traction, see paragraph 50 below), which could strengthen the case for these 16 schemes and which in the longer term could support the conversion to electric traction of an increasing proportion of the remaining non-electrified network.

45. Analysis produced to support the updated Electrification RUS suggests that at current rates of delivery this programme could take at least three Control Periods (CP6 to CP8 inclusive). It must be emphasised that such a programme does not in any way constitute Network Rail or government policy. Its adoption would be subject to a range of factors including the strength of business cases, the pace of technological development of alternative and more cost-effective electrification solutions, environmental and other priorities, and the availability of funding. Such a long-term programme would be broadly consistent with that previously modelled in the RSS, but with a lower annual rate and a longer overall timeframe. RSSSG has modelled such a programme for this edition of the RSS in order to determine the impact on the potential requirements for both electric (including bi-mode and battery-assisted) and non-electric vehicles.

46. Low, Medium and High scenarios for electrification have been constructed as shown in Table 1 below. This is a strategic view only, designed to give a potential sense of scale for the electrification programme beyond CP5. The ranking and evaluation of electrification schemes provides a pool of possible projects from which a long term rolling programme could be constructed. The RSS is intended to illustrate and quantify the implications which such a rolling programme might have for the national passenger rolling stock fleets.

Table 1 – Illustrative Electrification Scenarios (Track Miles that might be Electrified)

	Low	Medium	High
% Electrified	62% by 2034	67% by 2039	72% by 2045

47. Conversion of DC-electrified routes to AC or to dual-voltage capability has been ignored for the purpose of this analysis. The route between Basingstoke and Southampton had been proposed for such conversion but this is not being developed at present.

An Alstom Virgin Trains West Coast Type F Class 390 'Pendolino' train introduced in 2001

F. The Present Fleets and Future Capability Requirements

48. Details of the composition of all of the existing fleets, and of committed changes to the end of March 2016, are summarised in Table 2 below, using the definitions in paragraphs 16 and 17 above (and see also Appendix 4). The totals here and elsewhere in the RSS include both passenger-carrying and associated non-passenger carrying vehicles in passenger trains (the latter including locomotives, power cars and driving trailer vehicles).

Table 2 – Present Fleet Composition (including Committed Changes to March 2016)

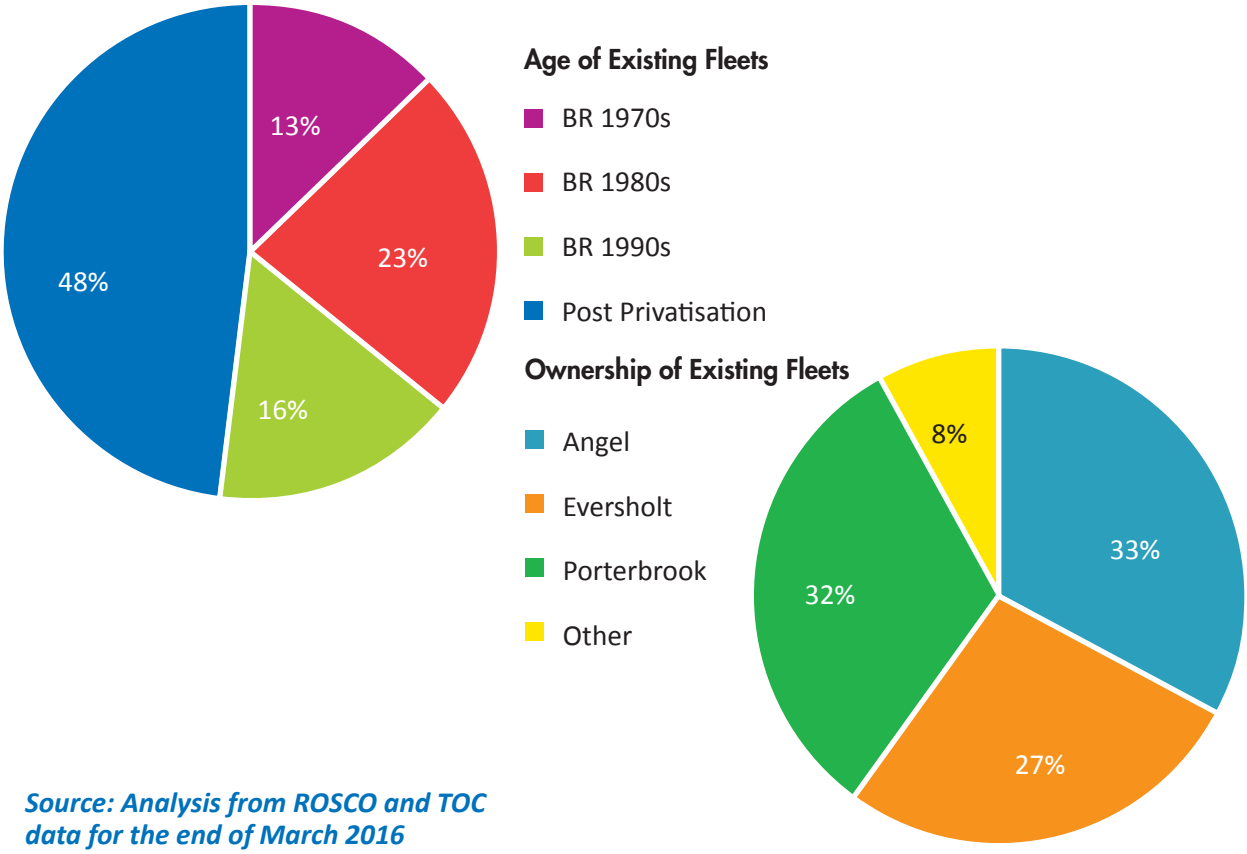
Generic Type	Total Vehicles, March 2016
A. Shorter Distance Self-Powered (diesel, generally with 75 mph maximum speed);	1,057
B. Middle Distance Self-Powered (diesel, with 90 or 100 mph capability);	1,368
C. Long Distance Self-Powered (diesel, with 100 or 125 mph capability);	1,500
D. Shorter Distance Electric (generally with 75 mph maximum speed);	2,461
E. Middle Distance Electric (with 90/ 100/ 110 mph capability);	5,260
F. Long Distance Electric (with 100/ 125/ 140 mph capability);	1,148
G. Very High Speed Electric (140 mph and above)	174
TOTALS	**12,968**

Source: Analysis from ROSCO and ATOC data for the end of March 2016.

49. Figure 2 on the next page shows that, of the 12,968 vehicles:
    - 6,247 (48%) have been built in the last 20 years; and
    - 1,065 (8%) are owned by parties other than the three largest ROSCOs.

A BR-procured Arriva Trains Wales Type A Class 143 'Pacer' DMU introduced in 1985

Figure 2 - Present Age and Ownership of the National Passenger Rolling Stock Fleet



Source: Analysis from ROSCO and TOC data for the end of March 2016

50. For the future, 'Self-Powered' units will include any type of train which cannot collect electrical power when in motion, from an overhead or third rail source. This may include classic diesel-powered units and also 'hybrid' units incorporating an internal combustion engine or fuel cell with some form of electrical or mechanical energy storage. 'Electric' units include not only pure electric but also 'bi-mode' trains (such as Hitachi's IEP Trains) which can both collect power when in motion from an overhead or third rail source, and also generate power from an on-board source. It is probable that some electric units may in future include some form of electricity storage for operation beyond or between overhead or third rail power sources. The recent trial fitment of an additional battery pack to a standard Class 379 EMU is the first such experimental project, this being known as the Independently Powered EMU (IPEMU). Future Railway has organised a competition to encourage the development of novel technical solutions for the next generation of self-powered vehicles. Both Future Railway and the Rolling Stock Portfolio group of the Technical Strategy Leadership Group (TSLG) propose to provide funding for an experimental self-powered unit that can demonstrate these and other innovative technologies. In the long term it will be important to develop an alternative power source for self-powered vehicles that is not dependent on diesel or other fossil fuels, for those routes that have a low priority or business case for electrification.

51. None of the present diesel fleets have engines that are compliant with EU legislation regarding emissions from diesel engines for new rail vehicles, known as Stage IIIB. The situation for these vehicles is as follows.
    - Existing EU and UK legislation does not prevent the continued operation of any of the present British DMU fleets, thanks to an amendment agreed in 2011.
    - None of the present British DMU fleets are at any risk of being unable to operate as a result of non-availability of diesel engines or spare parts for diesel engines.
    - Legislation prevents any more engines of the present types being manufactured for these fleets, but engine components can be manufactured and a float of additional spare engines will become available for the older DMUs when electrification starts to reduce the size of these fleets in future years.

- It is unlikely that a business case can be made at present to fit a Stage IIIB compliant diesel engine (or engines) to any of the existing British DMU types. The D-Train project being developed by Vivarail is however intended to demonstrate the feasibility, reliability and business case of fitting pairs of smaller Stage IIIB compliant automotive diesel engines beneath former LUL vehicles.

52. The diesel engines being fitted to the Class 800, 801 and 802 trains being built by Hitachi for the Great Western and East Coast TOCs are compliant with Stage IIIB, as will be the diesel and bi-mode vehicles being procured for the new ARN and FTPE franchises. The Class 68 locos now being used by Chiltern Railways and ScotRail are compliant with the previous Stage IIIA requirements.

53. Further discussion of new-built or additional self-powered rolling stock required in CP5 and CP6 is contained in Sections G and H on pages 15 to 20.

54. On the principal electrified (and to be electrified) high speed main lines, maximum route capacity and revenues will be achieved if high capacity, high performance electric trains with a maximum speed of 110 or 125 mph are introduced for middle distance flows. There are trade offs to be made between track capacity and the capacity of individual trains.

A Hitachi Type F Class 800 bi-mode 'Super Express Train', to be introduced on the Great Western Railway from 2017, at North Pole depot in West London

G. Fleet Sizes and Compositions Calculated for each Scenario

55. As described in paragraph 20 above, the three growth and capacity utilisation scenarios have been combined with three electrification scenarios to obtain three composite scenarios within the spreadsheet model to 2045, for each TOC. The aggregated results are summarised in Figure 3 and Table 3 below.

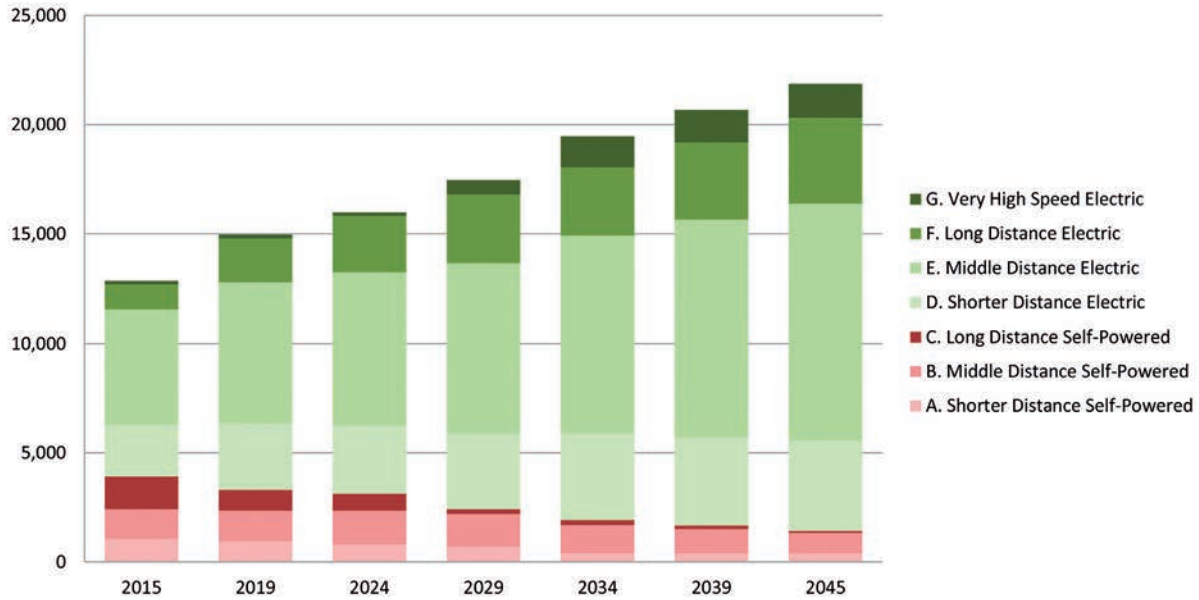
56. The key developments over 30 years highlighted in Table 3 are:
    - an overall increase of 51-99% in the size of the total national passenger fleet;
    - the electric fleets rising from 70% of the national fleet today to 90-95%; and
    - the self-powered fleets falling from 30% of the national fleet today to 5-10%.

57. It can be deduced that in the Low scenario, a minimum of 13,000 new electric vehicles would be required by 2045, from today's base position. This figure comprises the sum of:
    - 8,500 which is the net increase in electric vehicles over 30 years, in the Low scenario;
    - 4,500 to replace the BR-procured electric fleets (all of which will be a minimum of 50 years old in 2045).

58. In the Medium and High scenarios, this minimum total of 13,000 new electric vehicles to be constructed by 2045 would rise to 16,000 and 20,000 respectively. This equates to a construction requirement for electric trains averaging approximately 8, 10 or 13 vehicles per week respectively in the three scenarios over 30 years. This would be a significant increase over the average rate of construction of new electric and diesel vehicles during CP4 of just 4 vehicles per week. The rate of construction will however be higher than this during the five years 2016 to 2020 inclusive when more than 4,500 new vehicles will be built at an average rate of over 17 per week.

59. The projected changes in the size and composition of the national passenger fleet for the Medium Scenario are shown in Figure 3.

Figure 3 – Changes in Fleet Size and Composition, 2015 - 2045 (Medium Scenario)



Source: Analysis as in Table 3.

Table 3 – Aggregated Results of Fleet Size Changes for the National Passenger Fleets to 2045 (Low, Medium and High Scenarios)

	Committed	Forecast CP5, March 2019			Forecast CP6, March 2024			Forecast CP7, March 2029			Forecast CP8, March 2034			Forecast CP11, March 2045		
Sub-Group	**Total Vehicles**	**Total Vehicles**			**Total Vehicles**			**Total Vehicles**			**Total Vehicles**			**Total Vehicles**		
	March 2016	**Low**	**Med.**	**High**	**Low**	**Med.**	**High**	**Low**	**Med.**	**High**	**Low**	**Med.**	**High**	**Low**	**Med.**	**High**
A. Shorter Distance Self-Powered	1,057	922	944	966	763	802	816	655	697	714	498	404	423	507	394	395
B. Middle Distance Self-Powered	1,368	1,357	1,403	1,452	1,483	1,544	1,587	1,419	1,500	1,587	1,145	1,276	1,320	1,239	940	804
C. Long Distance Self-Powered	1,500	911	961	1,006	724	784	813	200	230	244	210	240	254	94	94	94
D. Shorter Distance Electric	2,461	3,012	3,021	3,030	3,084	3,110	3,136	3,267	3,449	3,666	3,666	3,960	4,313	3,745	4,135	4,604
E. Middle Distance Electric	5,260	6,391	6,453	6,507	6,808	6,998	7,111	7,413	7,785	8,348	8,332	9,043	10,126	9,134	10,825	13,094
F. Long Distance Electric & Bi-Mode	1,148	1,971	2,010	2,015	2,429	2,579	2,623	2,740	3,138	3,476	2,568	3,117	3,747	3,138	3,928	4,899
G. Very High Speed Electric	174	174	174	174	174	174	174	654	662	686	1,397	1,436	1,507	1,511	1,559	1,631
TOTALS	**12,968**	**14,738**	**14,966**	**15,150**	**15,465**	**15,991**	**16,260**	**16,349**	**17,461**	**18,721**	**17,816**	**19,476**	**21,690**	**19,368**	**21,874**	**25,521**
Effective Capacity Growth on October 2015	1%	15%	16%	18%	20%	24%	27%	27%	36%	46%	39%	52%	69%	51%	70%	99%
Self-Powered Totals	3,925	3,190	3,308	3,424	2,970	3,130	3,216	2,274	2,427	2,545	1,853	1,920	1,997	1,840	1,428	1,293
Electric & Bi-Mode Totals	9,043	11,548	11,658	11,726	12,495	12,861	13,044	14,075	15,034	16,176	15,963	17,556	19,692	17,528	20,446	24,228
Electric & Bi-Mode %	70%	78%	78%	77%	81%	80%	80%	86%	86%	86%	90%	90%	91%	90%	93%	95%

Source: Analysis using TOC-specific and route-specific peak period growth forecasts and illustrative electrification scenarios as described in this RSS.

60. A continuing programme of electrification would produce a flow of mid-life DMUs for potential use on non-electrified routes. On this basis it had originally been calculated that there would be only a small requirement for new diesel or other self-powered rolling stock in CP5 or CP6. The third edition of the RSS stated that small orders of additional new self-powered vehicles might be required, however. This has now been shown to be true, because of the combination of the continuing high rate of growth of passenger demand combined with the delays to delivery of the electrification programmes. The new fleets for the ARN and FTPE franchises are a reaction to this, DfT's decision to eliminate the 214 Pacer vehicles from the ARN franchise being a further factor. The creation of these new fleet types will probably encourage further orders of this kind for other franchises. As in these franchises, it is likely that the strongest business case will be achieved by introducing new self-powered vehicles of high capability (and hence maximum passenger benefit and incremental revenue) and then achieving a cascade of older vehicles onto more appropriate routes and/or to strengthen existing services. This is evidence of the market responding to a challenge and producing incremental benefits.

61. RSSSG has from the outset been actively engaged with RIA and with the train builders and other suppliers who are members of RIA during the development of this strategy. The involvement of all parties in these discussions has been extremely constructive, sharing key data and emphasising the most beneficial direction of travel for UK rail. This approach has developed RSSSG's thinking, further demonstrating the value of collaborative working.

62. Businesses in the rail supply chain have emphasised that the short, medium and long term forecasts stretching out 30 years which are provided in the RSS, far from being of merely theoretical interest, are of great value to their future business strategies, and have in specific cases been discussed in some detail with their parent companies. The RSG Sector Council has used the RSS as an example of the benefits of long term planning. Along with the National Infrastructure Plan, the DfT's franchise timetable and the plan for improving the visibility of future investments set out in the RSG strategy, the RSS forms part of a new set of complementary long term industry plans to help the supply chain understand future opportunities and plan to deliver this efficiently including by investing in people, innovation, facilities and equipment here in the UK.

63. The train builders and RIA have emphasised their firm belief that:
- the procurement of new rolling stock is normally best undertaken by TOCs in a competitive environment;
- the ROSCOs' role is crucially important for addressing residual value;
- procurement decisions should be based on optimisation of whole-system life-cycle value;
- procurement evaluation criteria and weighting for rolling stock investments must be transparent and proportionate;
- the DfT's approach to deliverability is important e.g. for 'new' vs 'life extended' rolling stock decisions, and in franchise bid evaluation;
- batch sizes and continuity of 'beat rates' (i.e. the rate of production) for new rolling stock have major impacts on build efficiency, cost, and ability to innovate; and
- full service maintenance provision by the manufacturer can in their view produce a better train, but typically needs a maintenance contract period of around 10 years to justify the investment required.

H. Rolling Stock Requirements in CP5 and CP6

64. For the previous editions and again for this fourth edition of the RSS, RSSSG felt it important to review the impact of its assumptions for the fleet over the remainder of CP5 and through to the end of CP6, covering the next eight years. This will form a key input to the IIPs for CP6 to be published in September 2016, and to the Industry Strategic Business Plans (ISBPs) for CP6 which it is expected will be published in January 2018.

65. As outlined in Appendix 5, our updated analysis indicates that 3,781 new electric or bi-mode vehicles and 79 self-powered vehicles are now committed for delivery in CP5 (for England, Wales and Scotland, and including TfL's rail concessions), these figures including the 2,240 electric or bi-mode vehicles for the Thameslink, Crossrail and IEP projects to be delivered by the end of CP5. This total of 3,860 compares with the figure of 3,349 new vehicles to be delivered in CP5 quoted in the February 2015 RSS. This is a very large requirement for new vehicles in a single five-year period, and can be compared with the total of 1,055 new electric and diesel vehicles delivered in CP4. Furthermore, a total of 643 electric or bi-mode vehicles and 61 self-powered vehicles have already been committed for delivery in the early years of CP6. The forecast delivery dates of committed new rolling stock (and of some other fleet requirements) in CP5 and early CP6 are shown in the Timelines contained in Appendices 1 to 3 of this RSS.

66. The total number of new vehicles committed for delivery in CP5 and in the early years of CP6 is therefore now over 4,500, compared with the 3,800 reported in the 3rd Edition of the RSS. These have a capital cost of more than £7.5 billion. Around 50% of these new vehicles will be built in Britain. The average age of the fleet is estimated to fall from 21 years to 16 years over this period. Significant investment will also be required to deliver additional functionality or to enhance the customer environment for existing fleets, as instigated by fleet owners, their TOC customers, or the franchising authorities.

67. The total number of new vehicles to be delivered in CP5 could yet rise further when the new East Anglia franchise and other new franchises are let. The ability of fleet owners to offer life extension and other enhancements to their TOC customers, on EMUs cascaded from the Thameslink and Crossrail projects, means that there is now an unprecedented degree of liquidity in the EMU market in Britain. New fleets will have the greatest advantages where they offer additional functionality and therefore greater overall value for money. The slower rate of electrification referred to in Section E above can however be expected to reduce the total number of new electric and bi-mode vehicles required in CP6 from what would otherwise have been the case.

68. Our updated fleet size forecasts contained in Table 3 of this RSS show the 'Electric and Bi-mode' fleet totals increasing by a net figure of between 950 and 1,300 over the course of CP6, in the three scenarios. This compares with a forecast net increase of between 2,800 and 3,000 vehicles over the course of CP5 (April 2014 to March 2019). It is not possible to predict how many older electric vehicles and electrically-hauled vehicles will be permanently retired during these control periods, and also how many mid-life EMUs which may temporarily be off-lease at the end of 2019 may move back into operational use during CP6. Nevertheless it appears probable on the basis of the assumptions contained in this analysis that the total number of new electric and bi-mode vehicles required to be delivered in CP6 will be less than in CP5.

69. The over-riding reason for this is that the Thameslink and Crossrail projects, and replacement of most of the InterCity 125 trains (HSTs) built in the 1970s, all represent major investments which had long gestation periods and are due to come to fruition in CP5. No similar rolling stock procurements of 600+ new vehicles are likely to occur in CP6. HS2 is however forecast to require around 500 new vehicles in CP7, with a further 700 to 800 in CP8.

70. A significant factor that may have impact in CP6 is TfL's aspiration for the TOCs' inner suburban routes in London. The consultation document "A New Approach to Rail Passenger Services in London and the South East" published by DfT, TfL and the Mayor of London in January 2016 refers to "new metro-style, high-performing trains with better acceleration and braking to speed up journeys. More and wider doors, plus more standing space, would allow faster boarding and alighting". Such trains are already in use on the London Overground, and another 180 are on order for that concession. The new trains for the Crossrail and Thameslink routes have these features. It is likely that significant investment may therefore be required to reconfigure and in some cases to replace inner suburban rolling stock in South London in order to achieve these objectives in the most cost-effective manner, whoever may operate these services in the future.

71. From a supply chain point of view, LUL's rolling stock requirements are a further factor. Although not considered in the RSS, it should be noted that the complete renewal of the Victoria Line and sub-surface fleets between 2009 and 2016 has required nearly 1,800 new vehicles, all built by Bombardier in Britain. The replacement of trains on the Piccadilly, Central, Bakerloo and Waterloo & City lines, commencing in the early 2020's, and for which the ITT has now been issued, will require similar total numbers.

72. A completely steady new build programme for rolling stock is unlikely ever to occur. Smaller peaks in demand for new build vehicles will occur as a consequence of refranchising timescales, where decisions to procure new rolling stock will, in many cases, be triggered by franchise award. Nevertheless, the forward projections of rolling stock fleet sizes offered by the RSS should provide a greater degree of predictability about orders for new vehicles beyond CP5.

73. The new liquidity in the EMU market referred to above is not replicated for DMUs. All of the Type A short-distance DMUs and many of the Type B DMUs were procured by British Rail between 1985 and 1992. It can be expected that most if not all of these will have been withdrawn by 2045, all being more than 50 years old at this time. A total of 1,350 Type B and Type C diesel vehicles have been built in the last 20 years. Most of these could still be operating in 2045, if environmental legislation and the supply of engines permit this. 140 new Type B DMUs have now been ordered for the new ARN franchise. Based on the figures in Table 3, a total of between 1,300 and 1,900 self-powered vehicles will be required in 2045. It is possible therefore that relatively few new self-powered vehicles may be required to be built in the 30 years to 2045. Alternatively if environmental legislation were to be strengthened, and/or quality factors were to become dominant, then up to 1,900 new self-powered vehicles may be required. This is a small figure compared with the 13,000 to 20,000 new electric and bi-mode vehicles forecast to be required over this period.

74. RSSSG has updated its previous detailed analysis and sensitivity testing of the shorter term requirements for self-powered trains in recent months, in the light of the Hendy Report announcements and the commitments to new vehicles contained in the new ARN and FTPE franchises. This has included detailed analysis of the total number of Type A and Type B vehicles likely to be required in each year to 2024. This work has indicated a potential requirement for a total of 100 to 200 additional non-electric vehicles beyond those already committed in those two new franchises, over this eight-year period. As with these franchises, it is probable that these new self-powered vehicles will be deployed on middle distance and inter-urban express services. The analysis assumes replacement of all of the 214 ARN Class 14x 'Pacer' vehicles, and the provision of additional vehicles for the alleviation of present levels of crowding and/or to permit future growth. This requirement might potentially be satisfied by various permutations of new construction and/or conversion of older vehicles, including loco-haulage in some instances, but the DfT's quality criteria in franchise ITTs are more likely to favour new vehicles. Concerns about how to 'future-proof' such an investment in new trains can be mitigated in various ways including:
    - building some of the trains as bi-modes, as for the new TPE franchise, assuming that the trains can potentially have long term value operating in both diesel and electric modes; or
    - building the trains as unpowered vehicles to be hauled or propelled by diesel, electric or bi-mode locomotives.

75. There will be some unsatisfied demand for self-powered vehicles in the short term but RSSSG is confident that the industry (TOCs, train builders and leasing companies) can provide solutions to these issues in CP5 and early in CP6, as has been demonstrated in the winning bids for the ScotRail, ARN and FTPE franchises. Life extension of older vehicles can still be an attractive and cost-effective solution, as demonstrated by Chiltern Railways' use of loco-hauled Mark 3 coaches, and ScotRail's future use of HSTs on its internal intercity routes.

76. Any further delays to the planned electrification completion dates in CP5 and CP6 would nevertheless have a number of adverse consequences for rolling stock:
    - Slower achievement of the additional capacity required;
    - The higher capital cost and whole-life, whole-system costs of additional new diesel vehicles compared with new electric vehicles, (see Section M on page 32);
    - Incremental costs associated with short initial leases, subsequent transfer to other non-electrified routes, and residual value risks; and
    - The lower reliability of diesel vehicles compared with electric vehicles (see Section J on page 23).

77. All rolling stock must comply with the legislation for Passengers of Reduced Mobility (the PRM-TSI requirements) by December 2019. The fleet owners have now let contracts for the great majority of this work to be undertaken, so far as possible during the downtime required for heavy maintenance. This commitment is still outstanding for some fleets however, principally where these fleets are subject to an impending franchise competition and/or will become redundant following electrification in CP6.

78. During CP5 and CP6, the European Train Control System (ETCS) will be fitted to many fleets in preparation for the operation of the European Rail Traffic Management System (ERTMS). The business case and affordability of accelerating implementation of ERTMS as part of the Digital Railway proposal is being evaluated as one of the scenarios for the IIP. Vehicle fitment of ETCS must in any case proceed at a faster rate than route fitment of ERTMS. According to the most recently proposed fleet fitment programme, 60% of all vehicles would be fitted by the end of CP6 and 80% by the end of CP7. The TOCs and fleet owners can potentially achieve whatever rate of fleet fitment is required to meet this or an accelerated programme, subject to careful management of fleet availability and system reliability issues. It will be damaging and expensive however if a firm and stable plan for ETCS fitment cannot be achieved in the near future. The present uncertainty runs the risk of waste of effort and cost. In some cases the timescale and costs of ETCS fitment may influence the decision as to whether a particular fleet should be life-extended or replaced.

I. Passenger Requirements and Benefits

79. RSSSG's calculations of the range of growth in the size of the national passenger fleet not only take account of the forecast growth in peak period passenger numbers, but also of the need to achieve compliance with peak period crowding standards where this is not the case at present.

80. Electrification will produce many passenger benefits, in terms of:
    - Increased fleet reliability and hence improved train punctuality;
    - Better acceleration and hence shorter journey times and greater route capacity;
    - Greater train capacity where diesel trains have included non-passenger carrying vehicles or where train capacity has been constrained by a shortage of non-electric vehicles;
    - Reduced noise, vibration, carbon emissions and improved air quality.

81. Many TOCs have introduced and subsequently improved WiFi provision, and improved passenger information systems, on trains. Intelligent traffic management systems, the Digital Railway and the provision of WiFi on all trains will provide much improved levels of real-time information to passengers, both in normal operation and during disruption.

82. In July 2015, DfT published a document entitled 'Rolling Stock Perspective – Moving Britain Ahead'. This sets out aspirations for passenger rolling stock which industry should work towards, with particular reference to passenger facilities. These are described in high-level terms, for four generic types of fleet – InterCity, InterUrban, Metropolitan and Rural/Regional. More detailed requirements are included as appropriate in the individual ITTs for franchise competitions, and it is understood that these will always take precedence over the more general aspirations contained in 'Rolling Stock Perspective'. Examples in the most recent ITTs for the Northern, TPE and East Anglia franchises include mandatory provision of WiFi, power sockets, and controlled emission toilets.

83. The document emphasises that "There is a great opportunity for the market in improving the design and styling of trains on the network and to put passengers at the heart of this, both through refurbishing existing stock and in the design of new trains".

84. Fleet-related passenger satisfaction is measured and monitored for all TOCs through the National Rail Passenger Surveys (NRPS). These have been conducted on a consistent twice-yearly basis by Transport Focus and its predecessors since the autumn of 1999. The surveys include 18 factors that relate to the design, maintenance, cleaning and operation of rolling stock. In the most recent NRPS survey conducted in the autumn of 2015, the average 'satisfied or good' score for 'Overall Satisfaction with the Train' was 81%, a 3% point improvement on the average score in autumn 2014. The score was highest for the Long Distance TOCs at 85%, and lowest for the L&SE TOCs at 80%. It is possible to track these scores for each TOC over time. It is apparent that the introduction of new rolling stock can (not surprisingly) cause a large increase in customer satisfaction, three good examples being c2c, London Overground and Virgin West Coast, but it is well recognised that such step changes in the train-related scores are affected by factors other than the rolling stock. The factors having the greatest impact on overall satisfaction and dissatisfaction are punctuality/ reliability and 'how a TOC deals with delays', respectively.

85. The franchised TOCs that had NRPS customer satisfaction figures of 90% or more for 'Overall Satisfaction with the Train' in the autumn 2015 survey demonstrate that such scores can be achieved by good overall management of train services without necessarily having a recently renewed fleet. For example, Merseyrail, whose fleet dates from 1978-80, had an overall score of 93%.

86. TOCs, the franchising authorities and other stakeholders all use the NRPS surveys as key performance indicators, backed up by data from complaints, social media and mystery shopping etc. For the design of new or refurbished trains, focus groups have value, often supported by mock-ups of proposed train interiors. There are examples of good practice by many TOCs, ROSCOs and train builders that have introduced new and refurbished rolling stock in recent years. The independent passenger representative bodies (Transport Focus and London TravelWatch) can provide qualitative and quantitative research and consultancy into rolling stock design, two recent examples being Transport Focus' work for HS2 and for Merseytravel.

87. Future rolling stock design will, as with the Class 378 for London Overground, S-Stock for LUL and Class 345 for Crossrail, be influenced by the need to optimise passenger entrance and egress as a key component of optimising total system capacity. Vehicle interior configuration, door width, stepping distances, and inter-car gangways are all components of this optimisation process.

88. Statutory requirements for on-train facilities for passengers with reduced mobility are being delivered (the PRM-TSI modifications). Greater emphasis will in addition be required to take account of the continuing upward trend of life expectancy of the national population, and of the mean and standard deviation of passengers' heights and weights.

Interior of a Bombardier London Overground Type D Class 378 'Electrostar' EMU of 2009

J. Fleet Reliability

89. As outlined in the previous section, punctuality and reliability are the principal factors determining the overall level of passenger satisfaction for any TOC.

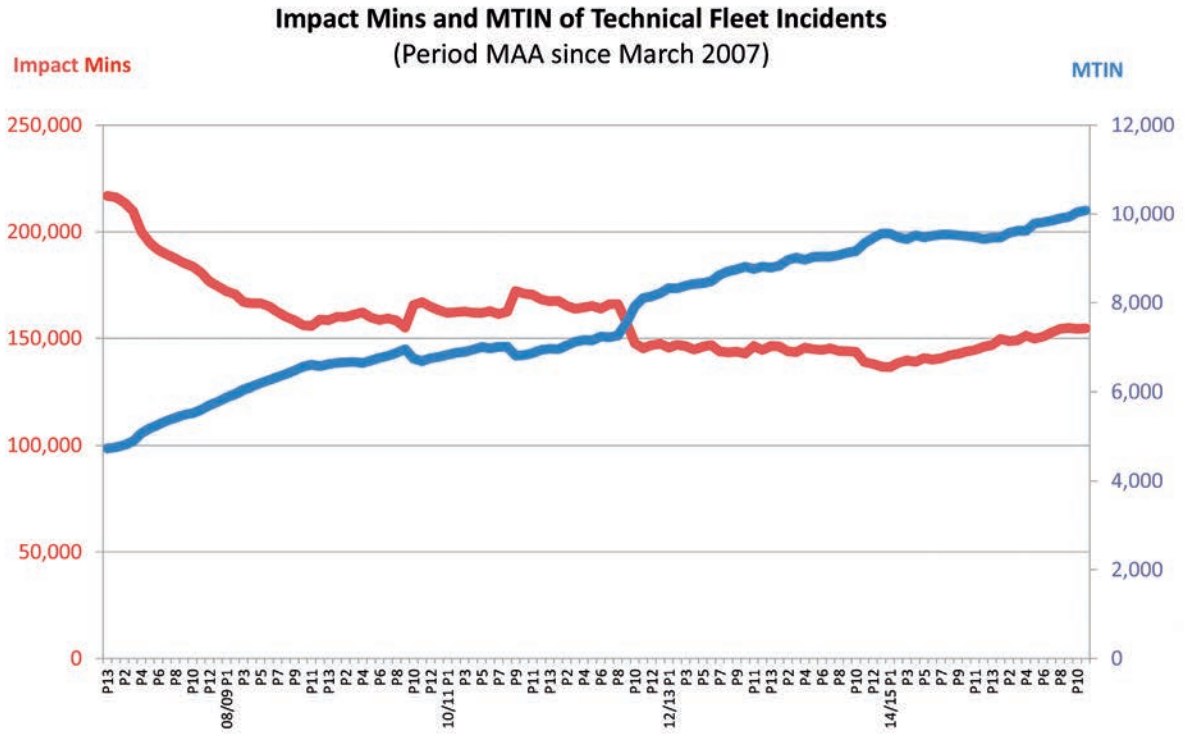
90. Strategic direction in setting the national planned performance levels for punctuality and reliability is provided by the industry's senior performance group, the National Task Force (NTF). The overall national fleet reliability improvement strategy is managed by a Fleet Challenge Steering Group. At a tactical level, reliability statistics for each TOC's fleets and sub-fleets are compiled, monitored and compared using a well established form of benchmarking originally introduced in 2001. This benchmarking and the associated sharing of good practice continues as 'ReFocus'. A 20-Point Plan encourages best practice for fleet reliability and other associated rolling stock issues across the industry, and this Plan is regularly updated.

91. The principal key performance indicator (KPI) adopted is the moving annual average of fleet related Miles per Technical TRUST Incident (MTIN MAA), these incidents being delays of three minutes or more, cancellations and part cancellations.

92. The other principal KPI measures are the MAA of fleet-related 'impact minutes' (i.e. delays caused by fleet technical issues), and the average Delay per Incident (DPI). In both cases cancellations and part cancellations are given a deemed delay-minute value.

93. The moving annual averages of total fleet-related impact minutes and of average MTIN are shown in Figure 4 for the period since March 2007.

Figure 4 - Rolling Stock Reliability Growth since March 2007



Source: ATOC and Network Rail, as monitored by NTF

94. In Figure 4 it can be seen that:
    - apart from during short periods of perturbation caused for example by extreme weather, the MAA of miles per technical incident (MTIN) has been rising steadily, and has improved over this period by more than 100%;
    - the MAA of total fleet-related delay minutes had fallen by around one third, but is now on an upward trend. Unlike the MTIN measure, total delay minutes are not normalised in relation to total mileage. Annual timetabled passenger train miles have increased by 18% over this period, while on many routes there are higher levels of peak passenger crowding. Any incident occurring will have greater reactionary impact than in past years unless management processes are improved to counteract this.

95. The MTIN of each TOC's fleets and sub-fleets is monitored every four weeks by ATOC on behalf of ReFocus, using data which excludes certain non-technical fleet related incidents. The results are aggregated into seven fleet types, for which the results as at Period 11 of 2015/16 (i.e. January 2016) were as follows:

Table 4, MTIN MAA Miles per Technical TRUST Incident, by Fleet Class Group

Fleet Class Group	MTIN MAA as at Period 11 2015/16
Modern EMU	37,237
Midlife EMU	18,515
Modern DMU	16,621
Other Intercity	15,315
Old Generation EMU	14,143
Midlife DMU	9,390
Old Generation DMU	7,433

Source: TOC Inputs to ATOC, used for ReFocus Benchmarking

96. In this Table 4 it can be seen that:
    - the 'Modern EMUs' have an MTIN MAA that is two or more times better than any other category of unit; and
    - the 'Old Generation DMUs' and 'Midlife DMUs' have significantly the lowest MTIN MAA.

97. Five of the individual 'Modern EMU' fleets are achieving MTIN MAA figures of more than 60,000. The relatively good reliability of the 'Modern EMU' fleets results from a combination of:
    - effective contractual arrangements and incentives;
    - the improved extent of system redundancy and other design features;
    - real-time condition monitoring, and the associated condition based maintenance; and
    - the inherent reliability of the traction systems of a modern EMU.

98. The contracts for the large new electric and bi-mode fleets now being built for the IEP, Thameslink and Crossrail projects contain strong incentives for still higher levels of reliability. These trains will all incorporate extensive system redundancy.

99. The Fleet Challenge Steering Group sets five-year targets for reliability improvement, using a combination of top-down and bottom-up inputs. The improvement required over the course of CP5 is 20%. The improvement target for CP6 has not yet been determined. It is possible to extrapolate significant improvement of the total national MTIN over time, as the composition of the national fleet changes as forecast in the RSS, as electrification progresses and as the proportion of Modern EMUs in the national fleet increases, in addition to the many other initiatives that are being and will be developed to improve the reliability of existing fleets.

100. Such initiatives with the existing fleets include:
- managing the impact of technical incidents;
- weather resilience, for summer, autumn and winter;
- making best use of remote condition monitoring and diagnostics;
- improvements to depot facilities;
- collection of data to achieve better timetables and to enable improved interfaces with operations management.

101. Experience has shown that the most effective forms of remote condition monitoring and diagnostics are systems that can provide operational data as well as technical data, and which are fed to staff in real time in the TOC's control office. This allows decisions to be made that can reduce the impact of a technical problem on a particular train, and also to identify operational errors for which additional training may be required. These have greater overall value compared with the remote diagnostic systems that are typically specified by train builders for their own development-related requirements. What is critical is the provision of useful and timely data. If this is not achieved the risk is that TOCs' depot staff will be overwhelmed by unusable data.

102. It can be difficult to make the business case for such systems, unless additional funding is provided, as was the in CP4 via the Network Rail administered Performance Fund. The short-term nature of the STAs has also made it more difficult for TOCs to make the business case for some reliability improving modifications, for some fleets.

103. Improvements to depot facilities are outlined further in Section L at page 29 below.

104. There are a number of risks to fleet reliability performance, in particular:
- the possibility of initially low levels of reliability for the large new fleets to be introduced in CP5 (though new fleets can out-perform the reliability of the fleets being replaced in a relatively short period);
- the initially higher than planned use of diesel power on the new bi-mode IEP trains on the GWML, as a result of the delay to electrification;
- the risk of temporary loss of reliability following major interventions such as re-tractioning or re-engineering (the Porterbrook Class 455 and Class 458/5 fleets and Eversholt Class 321 fleet being current examples), PRM-TSI or ETCS fitment, or the transfer of fleets between TOCs.

105. All of these risks require proactive management. The 20-Point Plan contains good practice for the reliability management of newly introduced or cascaded fleets.

A BR-procured Abellio Greater Anglia Type E Class 321 EMU introduced in 1988, being life-extended to the 'Renatus' specification by Wabtec at Doncaster

K. Sustainable Development, Technology and Standardisation

106. The industry adopted ten Rail Industry Sustainable Development Principles (SD Principles) in the ISBP for CP5 and has committed to embed them. The SD Principles are also supported by DfT and are a core element of the current franchising programme. Through franchising, operators are required to meet ambitious environmental and social goals in which rolling stock has an important role to play.

107. The industry outlined its traction carbon ambition for CP5 in the ISBP and is currently developing a CP6 ambition, based on the RSS, which will be included in the IIP. This will highlight key energy efficiency interventions that can reduce both carbon and cost, including but not limited to Driver Advisory Systems and DMU transmission replacement, and will identify on which rolling stock types they might be fitted.

108. However, the biggest opportunities for improving the sustainability of rolling stock are at the design stage and given the volumes of new rolling stock that are needed, embedding the SD Principles in rolling stock procurement is critical. Future rolling stock procurement and leasing exercises should take due account of worldwide best practice and emerging results from research and development (R&D) in sustainable rolling stock design and operation. There is some good practice, with both the new Crossrail and Thameslink rolling stock offering significant efficiency gains, but wider delivery is uneven. Ambitious improvements in energy efficiency should be a key requirement in all future specifications, with opportunities existing for technology transfer from other sectors, such as automotive and aerospace. Noting the success of the IPEMU battery-powered train trial, innovation in self-powered vehicles is likely to be a key issue for the future as is the efficient use of capacity throughout the day.

109. It should also be realised that life extension of rolling stock can produce carbon benefits compared with fleet replacement, and this factor should not be under-estimated.

110. Some important issues are highlighted in the **Key Train Requirements** document (see paragraph 118 below). As well as traction energy carbon emissions these include material sourcing, recyclability, providing accessibility to an increasingly ageing and diverse population, and the management of depots (see Section L at page 29 below). The informed procurement, manufacture and operation of rolling stock can also have a positive social impact, with consideration given to local regeneration, skills and the role of the SMEs in the supply chain.

111. RSSSG has discussed, at a strategic level, the potential advantages and drawbacks of increasing the degree of standardisation of trains and their subsystems in future. On the one hand, greater standardisation could potentially make it easier to move trains around the network at franchise re-let points, to achieve economies of scale in production, technical support and maintenance, to increase infrastructure cost efficiency and, potentially, to increase the number of suppliers of important train subsystems. On the other hand, it could inhibit technical innovation and significantly constrain the options open to bidders for franchises, which are important means to promote efficiency. RSSSG's experience is that, in this area as well as others, the industry (working through the processes that it already has, such as the **Systems Interface Committees,** see paragraphs 118 and 119 below) can effectively address many of the issues where the DfT might otherwise feel it needs to intervene, provided that the industry is left to operate and explore the full range of options itself.

112. The rate and degree of change in railway performance to meet future needs is increasingly difficult to afford and technically challenging to achieve by conventional solutions and sometimes requires trade-offs e.g. between capacity and performance. Technology created through R&D enables new value to overcome such challenges. It brings the railway system to a position where it is possible simultaneously to increase capacity, reduce whole life costs, become more efficient and improve passenger experience, through sustained investment in creating new capabilities. These capabilities will require a more rapid application of technologies across the whole railway system.

113. The **Future Railway** programme, a collaboration between the Rail Safety and Standards Board (RSSB) and Network Rail, is working with key industry stakeholders to develop 12 key capabilities from significant programmes of work covering the main chapters within the **Rail Technical Strategy** (RTS), which was published in December 2012. This has resulted in substantial R&D investments.

114. A small team within the Future Railway programme is now developing a coherent capability delivery plan to align future technology investments and deployment plans with the delivery of the 30 year RTS vision. The **TSLG Rolling Stock Portfolio Group** is helping with this by offering advice on certain of the key capabilities, including:
- reducing unplanned maintenance and hence minimising disruption to train services; and
- maximising train utility, e.g. gauging to enable larger vehicle and rolling stock consists.

115. The Group's inputs will be used in the drafting of a **Capability Delivery Plan** for the RTS. This is due to be published in September 2016.

116. A technology pipeline already exists and is accessible as a **Solutions Catalogue,** published by Future Railway. Embedded in the industry planning process, the technology pipeline will be reviewed in the light of any revisions to industry needs and applied to proposed delivery programmes where appropriate to achieve more efficient, better value outputs.

117. There are number of other areas in which the industry – mostly with suppliers and manufacturers – is working together, in the UK and at EU level, to address the standardisation issues as a means of improving value for money. These are described in the following paragraphs 118 to 124.

118. ATOC with the **Vehicle/Vehicle Systems Interface Committee (V/V SIC),** on which the whole industry including suppliers is represented, has published **Key Train Requirements** for rolling stock. These requirements are distilled from collective experience of procuring new trains and refurbishing existing trains by TOCs and ROSCOs over many years. They comprise a series of guidelines for procurement and refurbishment in areas that are not covered by mandatory standards, which the whole industry and other bodies contemplating these activities are expected and encouraged to follow.

119. A similar process has been used by the **Vehicle/Track Systems Interface Committee (V/T SIC)** to develop a better understanding of the interaction between train and track represented in the **Vehicle Track Interaction Strategic Model (VTISM),** which has been used to support a number of recent train procurements; and by the **Vehicle/Structures Systems Interface Committee (V/S SIC)** which is currently looking at options around standardised gauges and train-platform clearances.

120. It is not always recognised that the operation of the normal commercial process in franchising, train procurement and leasing since privatisation has, in practice, naturally led to the evolution of several large families of trains whose designs have continued to evolve, most particularly:
- Siemens' Desiro EMU (10% of the present national fleet);
- Bombardier's Electrostar EMU (19% of the present national fleet); and
- Bombardier's Turbostar DMU (4% of the present national fleet).

121. This happened because, once a manufacturer has developed a train type and this has been successfully proved in service by achieving the high levels of safety and reliability required on the UK network, there are natural commercial advantages in ordering more of those train types rather than incurring the expense and uncertainty of developing wholly new ones.

122. As part of the Interoperability Network Study, the rail industry is seeking to promote the adoption of standardised passenger rolling stock gauges on the rail network in Great Britain. This study will identify a baseline for current gauge clearance and a long term aspiration for a gauge cleared network which maximises the ability of rolling stock to operate on as many routes as possible. Rolling stock should be designed with the maximum utility across as many routes as possible; train builders and their customers should not design in bespoke features that constrain where the trains can be operated unless that is unavoidable. Maximised route availability will also reduce the impact of residual risk on the cost of lease rentals.

123. As route capacity has become more constrained, the **Route Planning Process** and Route Studies are playing an increasingly important role in setting expectations for the kind of rolling stock that should be used on busy routes. The process effectively sets high-level output requirements (e.g. for speed, acceleration, train length and door positions) for the rolling stock that might be deployed on each route, reflecting the fact that capacity on a route is maximised when the various train types that use it have similar path-occupancy characteristics. For example, the fast pair of tracks on the Great Western, West Coast, Midland and East Coast Main Line routes are now (or will be) used by modern electric trains operating at 125mph (or above), all with very rapid acceleration. Similarly, on the dense commuter routes, assumptions about door positions and widths, as well as train acceleration/de-acceleration, underpin route plans to increase capacity, facilitate passenger access and egress from trains, and reduce crowding. In each case, de facto, an output 'standard' for the kind of train that can operate on each busy route is being defined and there is an opportunity to address this more strategically as each of the Route Strategies are developed over the next three years through the LTPP.

124. European TSIs, which apply to new vehicles and to significant modifications of existing ones, will progressively introduce standards that are designed to remove country-based technical differences to allow suppliers to achieve economies of scale and to make it easier to operate and move trains across international borders. It is hoped that this process will be further facilitated by the **Shift²Rail** Joint Technology Initiative in which €450 million of European Commission funding will be matched by a similar sum from the rail industry for rail research and innovation in rolling stock, infrastructure, and traffic management and control systems. Alstom, Bombardier, Siemens and Network Rail are all founding members of Shift2Rail.

BR-procured Northern Rail Type E Class 319 EMUs introduced in 1987, at Liverpool Allerton depot

L. Depots, Stabling and Infrastructure Requirements

125. Plans for the additional maintenance depot capacity and berthing sites required for the large expansion of fleet sizes in CP5 are already well advanced.
    - Several new depots have already been constructed or adapted (e.g. at Reading, Liverpool Allerton, London North Pole (Hitachi IEP) and Three Bridges (Siemens Thameslink).
    - Construction is well advanced for the other new and reconfigured depots and berthing locations required for the IEP, Thameslink and Crossrail fleets.
    - The depot and stabling capacity that will be required for fleet growth in the ScotRail, ARN and FTPE TOCs is committed by the new franchisees.
    - The ORR included a £312 million Depot and Stabling Fund for other depot and stabling enhancements (e.g. for electrification schemes in England and Wales) in its determination of Network Rail's funding requirements in CP5.

126. Further work still needs to be done to develop the depot and berthing strategy for routes committed for electrification in CP6, in particular for the MML.

127. A pan-industry Depots and Stabling Steering Group (DSSG) has now been created. This group will quantify and prioritise longer term requirements, accepting the principle that additional depot and stabling capacity should be franchise bidder-led wherever possible. Good practice is recorded in **Design Considerations for Rail Maintenance Depots** published by Network Rail in 2012, and in **Key Depot Requirements** published by ATOC in 2014.

128. DSSG is delivering the Depots and Stabling workstream for the IIP for CP6, using inputs from RSSSG and from the IIP Rolling Stock workstream, while also carrying out an audit of the capacity and capability of existing depots and stabling points.

129. The overall fleet size increases from 2019 to 2024 and from 2019 to 2045 are around 10% and 50% respectively in the Medium scenario. Depot and stabling capacity is already an issue in the London area and the scale of fleet expansion required to serve the South East means that it may be prudent to attempt a higher level strategic review of possible sites, for the next round of Route Studies. Some Network Rail-owned sites will require to be safeguarded for future depot and berthing uses in the longer-term. This has become a key issue as a result of Network Rail's wish to dispose of non-operational sites in order to fund its enhancements commitments in CP5. Conversely, there could be some opportunities to rationalise (or possibly build over) depot and berthing capacity in some locations, particularly close into London, given high land values.

130. A critical factor to be considered is the maximum length of trains to be stabled or maintained at existing locations and how this compares with the current capability. Increases in train length have a big impact on the siding space required and on alterations required to depots. Additionally, understanding the eventual maximum train length for a given route will enable trains and depots to be procured with provision from the outset for 'future proofing', as for the new Crossrail depot at Old Oak Common. There have been past examples of train lengthening that have taken place or have been attempted that have incurred higher costs than necessary and where a depot's physical constraints have restricted the TOC's or maintainer's ability to achieve the optimal fleet availability and maintenance regime.

131. Outside London, various large brownfield sites adjacent to railway lines (and often with present or past rail connections) exist outside railway ownership. Some of these could potentially be suitable for new depots or berthing locations. It is important that future depot planning addresses not only forecast growth and the shift toward more and longer electric trains, but also considers solutions for depots that are already known to pose significant operational constraints for one or more TOCs.

132. DSSG's review of depot capability will also consider strategic issues such as the requirement for universal deployment of controlled emission toilets and the optimal provision of expensive plant such as wheel lathes, but also the opportunity to adopt innovative technology for depots that can improve fleet reliability and staff efficiency. This can include the wider deployment of automatic vehicle inspection systems e.g. trackside acoustic bearing monitoring, cameras monitoring underframes and vehicle gauge, and pantograph checking equipment. Decision support tools can enable better management of technical incidents and the return to depot of degraded units in service, so improving depot loading and utilisation. We have also seen automation and process improvements in depots, for example to dispense maintenance consumables. There is probably more research to be done here in CP5 and CP6, in order to enhance productivity in CP6 and CP7.

133. Depots have a significant environmental footprint and the DSSG input to the IIP will include consideration of sustainability best practice in the selection of depot locations, and the design, enhancement and construction of depots. This is also embedded in franchising commitments, with requirements to reduce non-traction energy use, fit water meters and send zero waste to landfill. RSSB is currently developing best practice guidance on building energy efficiency technology for the industry, which will include depots.

134. Significant investment will be required to upgrade older depots which are barely adequate for their present fleets, let alone for the next generation of trains. Furthermore, the need for safe working with 25kV EMUs will necessitate substantial modification to some existing DMU depots if these are to remain in use following electrification. In some locations it will be more cost-effective to construct a new depot on a new site.

135. As regards who should provide new and manage new or existing maintenance depot sites, TOCs or manufacturers, there is no single correct answer, and both are likely to have a long term role going forward. Such decisions should be market-led rather than centrally-imposed.
    - The new Crossrail, Thameslink, and IEP fleets and the new ScotRail EMUs will increase the extent of manufacturer involvement.
    - Some TOCs who procure new fleets are likely to prefer to be largely responsible for maintenance themselves, especially where these are generic trains with limited technical risk.
    - Where a greater degree of innovation is offered with new fleets, some TOCs may prefer to involve the manufacturer in a medium term or long term relationship.
    - In some cases, TOCs may choose to let a maintenance contract to the manufacturer, but with defined future break-points.

136. It is important to emphasise the adverse consequences of not providing adequate and suitable depot and stabling facilities beyond CP5. This could otherwise have a detrimental impact on the effective and efficient deployment of the national rolling stock fleet. Despite attempts to raise its profile, this area remains under-valued. DSSG will develop a longer-term vision that transcends franchise boundaries and reletting timescales.

137. People issues are critical to the success of the railway industry, and this is certainly true for rolling stock maintenance issues. Short term franchises have not always given sufficient incentive for TOCs to invest in recruitment, training and development of engineering staff at all levels. The introduction of new fleet types, new technology, larger fleets and electrification must be accompanied by adequate long term investment to provide the skills necessary to underpin the required business results.

138. The National Skills Academy for Rail (NSAR) has an important role in quantifying potential future gaps in engineering skills, and in developing new tools such as 'skills passports' to enable railway staff to work across the industry. The potential "skills gap" is most acute for the traction & rolling stock sector where 14,500 staff are currently employed today for the design, construction, development and maintenance of rail vehicles. (This figure includes freight and LUL). Over the next 10 years, NSAR has estimated that:
    - 4,900 new staff will be required to replace retirements;
    - 3,300 additional staff will be required for growth in the sector (net of technology changes);
    - Hence a total of 8,200 new staff will be required, equivalent to 57% of today's workforce.

139. There will also be a need for a more systematic approach to career development across the industry to ensure that sufficient numbers of high quality engineering managers are available with the leadership and technical skills required for future years. Two major injections of new training resources will come from:
    - The National Training Academy for Rail (NTAR) at Northampton. This has been established by Siemens and NSAR, with support from the DfT and the Department of Business Innovation and Skills (BIS) for the rail industry, and is now operational.
    - The National College for High Speed Rail, now funded to construct and commission its two sites in Birmingham and Doncaster, with training to commence in the autumn of 2017.

140. The Transport Infrastructure Skills Strategy published in January 2016 has outlined how the Government's commitment to 30,000 apprenticeships in this sector by 2020 is to be achieved.

141. The scale of future additional berthing required for each devolved Network Rail Route is also indicative of the scale of infrastructure investments that will be required on each of the routes. This requirement is being developed through the industry's LTPP and IIPs, and specifically through the Route Studies. These are documenting a range of route-specific solutions including:
    - longer trains, in particular (but not solely) where electrification occurs;
    - increases in the number of trains per hour, produced by:
        - more homogeneity in the performance characteristics of rolling stock types on specific routes;
        - the Digital Railway, including shorter headways between trains produced by changes to signalling, driver advisory systems, ERTMS (initially at Level 2 and subsequently at Level 3), intelligent automated traffic management and centralised train control systems;
    - incremental infrastructure – elimination of bottlenecks and the provision of additional running lines; and
    - totally new infrastructure.

142. All of these solutions (except ERTMS Level 3) are already being adopted in the investment programmes now committed and being delivered for CP5, and being developed for the CP6 IIPs. All funders have to face strategic options of affordability and value for money in their infrastructure investment programmes. The scale of growth anticipated in this RSS and outlined in the Network Rail Market Studies indicates the need not only for HS2 plus ongoing incremental investment in many routes, but potentially also for additional completely new infrastructure (e.g. Crossrail 2), and other major enhancements for example on the main lines to and from London's Paddington and Waterloo stations.

M. Improving Value for Money from the Rolling Stock Fleets

143. In the first and subsequent editions of the RSS, RSSSG estimated the cost per vehicle mile of similar new EMU and new DMU vehicles, derived from several TOC and ROSCO sources, the confidential data being merged and anonymised. In doing so RSSSG considered and tabulated typical costs per vehicle mile for the following:
    - Fleet maintenance;
    - Capital leases;
    - Energy;
    - Track maintenance; and
    - Electrification fixed equipment.

144. We are not proposing to update the previous comparisons because no new DMU vehicles were procured for British TOCs between 2008 and 2016. The fleets of comparable new Type B DMUs and Type E EMUs to be built by CAF for the ARN franchise could provide an updated comparison but it would be inappropriate to publish figures for these fleets in isolation.

145. In practice the costs per vehicle mile for new DMU and EMU fleets will vary for each contract, depending on factors including:
    - how development costs have been amortised;
    - the cost of capital at a particular time;
    - the annual mileage and duty cycle of each fleet;
    - maintenance arrangements; and
    - other factors included in the commercial terms of the contracts, e.g. performance incentive regimes.

146. The business case for any electrification project must be based on the specific characteristics of the route and service groups to be electrified e.g. route characteristics such as the number and extent of overhead structures requiring increased clearance for the overhead power supply, and the potential for revenue growth, in addition to the potential for reduction of operating and fleet maintenance costs.

147. RSSSG stands by its original statement that (other matters being equal), the requirement for subsidy per passenger mile can be reduced (or the net premium per passenger mile can be increased) through a combination of electrification, passenger-mile growth and other changes, provided that electrification projects are prioritised in respect of their business case.

148. As stated in previous editions of the RSS, in general terms, the maintenance costs of diesel vehicles are significantly higher than those of similar electric vehicles because of the additional costs of fuelling, servicing, maintenance and repair of the engines and transmissions of the diesel vehicles.

149. Capital lease costs are higher for new diesel vehicles than for similar new electric vehicles because of the higher initial capital cost, and also because of lessors' concerns about their ability to lease diesel vehicles in the medium to longer term as the total size of the national self-powered fleet falls. This residual risk factor can be reduced if some new electric trains are built with bi-mode capability, but bi-mode trains are heavier and have higher maintenance costs compared with the equivalent electric trains.

150. The average price paid by TOCs for traction electricity per vehicle mile in 2014/15 was still significantly less than the price paid by TOCs per vehicle mile for diesel fuel. Oil prices have overall been falling for over 18 months, causing a decline in diesel prices, an effect that is also causing the wholesale market price of electricity to reduce somewhat although this market is more driven by shifts in gas than oil pricing. Due to forward hedging, it may be that these price falls will be more prominent next year. Drops in electricity prices are however being offset by rising costs of renewable and similar levies, which are certain to continue to increase each year until the end of the decade at the very least depending on the direction of government policy.

Energy markets are always volatile and there is no certainty that oil prices will stay at their current low levels in coming years. Decisions on further electrification would, in any event, always need to be taken on the basis of a long term view on the difference between diesel and electricity prices, including future levies, not just the current market differential.

151. In the last 15 months RSSSG has expended considerable effort in ranking and evaluating a range of initiatives by which rolling stock related costs could be reduced, and/or overall rolling stock value for money be increased, during CP5 and CP6. This work has related to the existing electric and diesel fleets. The issues and initiatives examined have included:
    - the costs of fleet maintenance and spare parts;
    - the total costs of energy used by trains;
    - train leasing costs;
    - track maintenance costs;
    - train utilisation; and
    - Government policy and planning horizons.

152. RSSSG identified work already being undertaken and also potential barriers to implementation. It then defined specific proposals that could deliver financial benefits in CP5 and subsequent years. Data was provided in anonymised form by RSSSG members, and by other parties.

153. The analysis undertaken identified that:
    - substantial cost savings are already being delivered for these initiatives, by the TOCs, ROSCOs, train builders and their supply chain and Network Rail working together through productive commercial relationships;
    - there is evidence that the industry is now increasingly seeking longer term whole-system optimisation, in addition to shorter term cost reductions;
    - this has been facilitated by changes to the franchise model with its encouragement of longer term planning, and also by the increased predictability of the franchising process; and
    - it is also significant that TOCs are now, to a greater extent than previously, incentivised to implement change and investment part-way through a franchise.

A BR-procured Grand Central Type C InterCity 125 High Speed Train introduced in 1976

N. Conclusions

The Principle of Franchise-Led Procurement

154. Government policy is that rolling stock procurement should in most cases be franchise-led and the RSSSG fully supports this principle.

155. It is still important that:
- guidance from DfT should not be interpreted as, and should not become (however inadvertently), the specification of inputs;
- short term savings in rolling stock costs to meet the DfT's budget constraints should not be made at the expense of whole-life, whole-system value; and
- the need for short term action should not constrain competitive tension and innovation.

156. Articulating the required outputs and allowing the market to decide the optimal means of delivering these will produce the following benefits:
- Optimised long term, whole-system benefits from investment in and deployment of rolling stock.
- A spur to investment in innovation.
- A strengthened supply chain with greater production capacity for both new and life-extended fleets.
- Reduction in the overall costs of enhancements (e.g. where these can be combined with PRM-TSI modifications, ETCS fitment and/or heavy maintenance).
- Lower cost of capital and improved value for money.
- Earlier delivery of passenger benefits, revenue increases, and carbon reduction benefits.
- Greater value for DfT from future franchise bids.

The Size and Composition of the Future National Fleet

157. The forecasting methodology for this fourth edition of the RSS has been refined but the long term conclusions are largely unchanged. The combination of exogenous growth, growth resulting from investment in new and electrified and upgraded railway infrastructure, and growth stimulated by TOC initiatives will require a major change in the size and composition of the national passenger fleet over the next three decades. With the assumptions and scenarios modelled in this RSS, the total size of the national fleet is forecast to grow by between 51% and 99% over 30 years, while the proportion of electric (and bi-mode) vehicles would rise from 70% today to more than 90% by 2034 over the same period.

158. The consequence of the modelled scenarios is that between 13,000 and 20,000 new electric vehicles would be required over the next 30 years, taking account of growth, electrification, replacement by 2045 of most BR-procured vehicles, and HS2. This equates to a build rate of between 8 and 13 electric vehicles per week and may be compared with an average build rate of just four (diesel and electric) vehicles per week in CP4.

159. The total number of new vehicles committed for delivery in CP5 and in the early years of CP6 is now over 4,500, compared with the 3,800 reported in the 3rd edition of the RSS, at a capital cost of more than £7.5 billion. Around 50% of these new vehicles will be built in Britain. The average age of the fleet is estimated to fall from 21 years to 16 years over this period.

160. Our updated fleet size forecasts show the 'Electric and Bi-mode' fleet totals increasing by a net figure of between 950 and 1,300 over the course of CP6 in the three scenarios. This figure is smaller than previously forecast because of the slower than anticipated completion of Network Rail's electrification programme. This compares with a net increase of between 2,800 and 3,000 over the course of CP5. It appears probable on the basis of the assumptions contained in this analysis that the total number of new vehicles required to be delivered for the franchised TOCs in CP6 will be less than in CP5, but this number may be increased by additional new rolling stock for the inner suburban routes in South London, and for LUL's deep tube routes.

161. A completely steady new build programme for rolling stock is unlikely ever to occur. Further peaks in demand for new build vehicles will occur as a consequence of refranchising timescales, where decisions to procure new rolling stock will in many cases be triggered by franchise award. Nevertheless the forward projections of rolling stock fleet sizes offered by this RSS should provide a greater degree of predictability about orders for new electric vehicles beyond CP5.

162. It is apparent that the difference in the net cost of ownership of new and life-extended EMUs has closed in the last year, due principally to a reduction in the capital cost of and the cost to finance new vehicles. Refurbishment of existing rolling stock still provides a cost effective way of enhancing the passenger experience and ensuring that capacity remains.

163. As forecast in the February 2015 RSS, some new and/or additional non-electric vehicles will be required in CP5, and in early CP6, as a result of:
- the existing levels of crowding and continuing strong growth of passenger demand on some non-electrified routes;
- the withdrawal of all of the 'Pacer' vehicles from the ARN franchise by December 2019; and
- the slower than anticipated rate of completion of the committed programme of electrification.

164. RSSSG has updated its previous detailed analysis of the total number of Type A and Type B vehicles likely to be required in each year to 2024. This work has indicated a potential requirement for 100 to 200 additional Type B self-powered vehicles, beyond those already committed in the new ARN and FTPE franchises. In the longer term, based on the amended electrification assumptions adopted for this edition of the RSS, up to 1,900 new self-powered vehicles may be required over this 30-year period. This is a small figure compared with the 13,000 to 20,000 new electric vehicles forecast to be required over this period.

165. The commitment to new self-powered and electric vehicles for the ARN franchise, and bi-mode and electric vehicles for the FTPE franchise, confirm RSSSG's confidence that the industry (TOCs, manufacturers and leasing companies) can provide solutions to these issues in CP5 and in CP6.

166. On many routes, the growth projections of this RSS would also require potential enhancements to permit the operation of longer trains, to permit shorter headways between trains, or to provide additional infrastructure. The industry's Long Term Planning Process will progressively shape what schemes might need to be considered for funding in future control periods to support this. Equally, changes in areas such as timetable structure, train utilisation and fares policy could additionally affect infrastructure and rolling stock requirements.

Electrification, Cost Reduction and Value for Money

167. Rolling stock-related costs per vehicle mile can be reduced in real terms as a result of these changes because the cost of leasing and maintenance for new electric vehicles are substantially lower than the costs for comparable new diesel vehicles; also these costs for older electric vehicles are significantly less than for comparable older diesel vehicles. Future energy costs and the relative costs of diesel fuel and electricity are in contrast very difficult to forecast. Electricity costs are currently rising to help pay for lower carbon sources, while diesel fuel costs have fallen sharply. Decisions on further electrification will always need to be taken on the basis of a long term view on the difference between diesel and electricity prices, including future levies, not just the current market differential.

168. The presently committed programme of electrification will take the proportion of track mileage that is electrified from 41% to 51%. The Low, Medium and High scenarios in this RSS illustrate the potential to increase this figure to 62%, 67% or 72% in subsequent years. The adoption of such a programme would be subject to a range of factors including the strength of business cases, the pace of technological development of alternative and more cost-effective electrification solutions, environmental and other priorities, and the availability of funding.

169. Electrification will also produce journey time improvements, route capacity benefits, revenue increases, fleet reliability improvements and substantial carbon reduction advantages. The impact of the RSS is potentially good news for the economy and could offer additional employment and business opportunities – in manufacturing, maintenance, installation and the associated supply chains, for vehicles and electrification; and in programmes for cost-effective life extension and re-tractioning of older vehicles.

170. RSSSG has assessed a variety of initiatives (including issues relating to maintenance, energy, train utilisation and train/track interface costs), by which rolling stock cost efficiency could be improved during CP5 and CP6. The analysis undertaken identified that:
- substantial cost savings are already being delivered for these initiatives, by the TOCs, ROSCOs, train builders and their supply chain and Network Rail working together through productive commercial relationships;
- there is evidence that the industry is now increasingly seeking longer term whole-system optimisation, in addition to shorter term cost reductions;
- this has been facilitated by changes to the franchise model with its encouragement of longer term planning, and also by the increased predictability of the franchising process; and
- it is also significant that TOCs are now, to a greater extent than previously, incentivised to implement change and investment part-way through a franchise.

Depots and Berthing

171. The scale of increase in fleet sizes outlined in this RSS will require additional berthing locations and some new maintenance depots. Provision of this capacity for CP5 is already well advanced. Our analysis shows that a further increase in berthing capacity of around 10% will be required to 2024, and 50% to 2045, in the Medium scenario, these increases being relative to total capacity at the end of CP5 in 2019. Provision of additional depot and stabling capacity should be franchise bidder-led wherever possible.

172. Some Network Rail-owned sites will require to be safeguarded for future depot and berthing uses in the longer-term. This has become a key issue as a result of Network Rail's wish to dispose of non-operational sites in order to fund its enhancements programme in CP5.

173. The Depots and Stabling Steering Group's review of depot capability will also consider strategic issues such as the requirement for universal deployment of controlled emission toilets and the optimal provision of expensive plant such as wheel lathes, but also the opportunity to adopt innovative technology for depots that can improve fleet reliability and staff efficiency.

174. It is important to emphasise the adverse consequences of not providing adequate and suitable depot and stabling facilities beyond CP5. This could otherwise have a detrimental impact on the effective and efficient deployment of the national rolling stock fleet. Despite attempts to raise its profile, this area remains under-valued. A longer-term vision is needed that transcends franchise boundaries and reletting timescales.

175. People issues are critical to the success of the railway industry, and this is certainly true for rolling stock maintenance issues. The introduction of new fleet types, new technology, larger fleets and electrification must be accompanied by adequate long term investment to provide the leadership and skills necessary to underpin the required business results.

Passenger Benefits and Fleet Reliability

176. The direction of travel described in this RSS, combined with a continuing programme of electrification, will produce many benefits for passengers, including:
- improved fleet reliability, producing improvements in punctuality;
- train capacity and route capacity, hence a reduction in crowding levels;
- shorter journey times and station dwell times;
- on-train ambience;
- reduction of noise, vibration and emissions;
- improved facilities for passengers with reduced mobility;
- on-train communications and WiFi.

177. The reliability of the total national passenger fleet as measured by the MTIN MAA benchmarking data has been rising continuously over several years. It is notable that since March 2007:
- apart from during short periods of perturbation caused for example by extreme weather, the MAA of miles per technical incident (MTIN) has been rising steadily, and has improved over this period by more than 100%;
- the MAA of total fleet-related delay minutes had fallen by around one third, but is now on an upward trend. Unlike the MTIN measure, total delay minutes are not normalised in relation to total mileage. Annual timetabled passenger train miles have increased by 18% over this period.

178. Furthermore:
- the 'Modern EMUs' now have an MTIN MAA that is two or more times better than that of any other category of unit; and
- the 'Old Generation DMUs' and 'Midlife DMUs' have significantly the lowest MTIN MAA.

A Siemens Type E Class 700 'Desiro City' EMU, to be introduced on the GoVia Thameslink routes from 2016

APPENDIX 1, TIMELINE OF KEY ACTIVITIES RELATING TO LONDON & SOUTH EAST FRANCHISES

Item	Start	Finish	2014				2015				2016				2017				2018				2019				2020				2021				2022				2023				2024			
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
SE Franchise STAs	10/2014	6/2018																																											
100 Class 377 vehicles sub-leased from GTR to SE		12/2017																																										
SE New Franchise	6/2018																																												
c2c Franchise	9/2014	9/2029																																											
c2c New EMUs (68 cars)	12/2019	12/2021																																											
GTR Franchise	9/2014	9/2021																																											
GTR New Class 387/1 EMUs (116 cars)	12/2014	7/2015																																											
Southern merged with GTR	7/2015	7/2015																																											
GTR New Class 387/2 Gatwick EMUs (108 cars)	2/2016	9/2016																																											
GTR New Class 700 EMUs (1,140 cars)	4/2016	6/2018																																											
GTR New Moorgate EMUs (150 cars)	9/2018	12/2018																																											
Thameslink Key Output 2 incl ERTMS		12/2018																																											
Crossrail Concession	5/2015	5/2023																																												
Crossrail, New Class 345 EMUs (594 cars)	5/2017	7/2019																																											
Airport Jn – Maidenhead Electrification		6/2017																																											
Crossrail Core and Abbey Wood Services		12/2018																																											
Crossrail to Shenfield		5/2019																																											
Crossrail to Reading		12/2019																																											
AGA Franchise STA	7/2014	10/2016																																											
EA new Franchise	10/2016	10/2025																																											
LOROL Concession Extension	11/2014	11/2016																																												
LOROL New Class 378 EMUs (57 cars)	11/2014	12/2015																																											
Overground Full 5-car Operation		12/2015																																											
Overground New Concession	11/2016																																												
TfL New EMUs for West Anglia etc. services (180 cars)	12/2017	10/2018																																											
Gospel Oak - Barking Electrification		6/2017																																											
SWT Class 458/5 conversion (180 cars)	3/2014	6/2016																																											
SWT New Class 707 EMUs (150 cars)	6/2017	12/2017																																											
SWT Full 10-car Operation (Inners & Reading)		12/2018																																											
SWT Franchise STA	1/2015	6/2017																																											
SW New Franchise	6/2017																																												
Chiltern Train Lengthening		8/2015																																											
Chiltern Services to Oxford		12/2016																																											
East West Rail, Oxford - Bletchley/ Bedford		tbc																																											
East West Rail Electrification, Oxford to Bletchley		CP6																																											
Chiltern New Franchise	12/2021																																												

Franchise STAs | New Franchises | Electrification Complete | Other Infrastructure Complete | Committed New Rolling Stock | Other Rolling Stock

Network Rail dates are as in the Enhancements Delivery Plan Update dated January 2016, quoting when infrastructure is planned to be authorised for passenger use

APPENDIX 2, TIMELINE OF KEY ACTIVITIES RELATING TO INTERCITY FRANCHISES

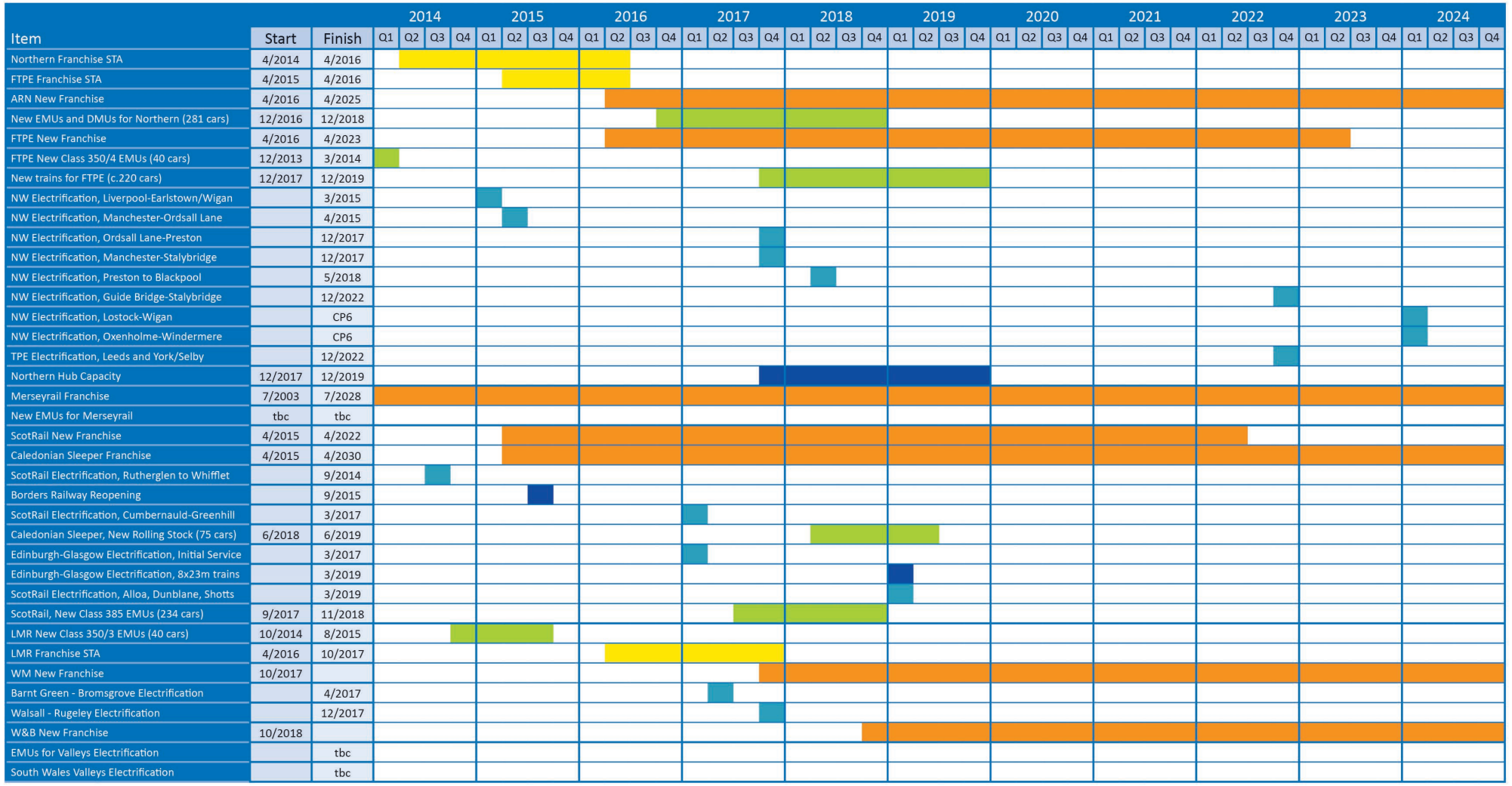
Item	Start	Finish	2014				2015				2016				2017				2018				2019				2020				2021				2022				2023				2024			
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
GWR Franchise STAs	10/2013	3/2019																																											
GW New Franchise	3/2019																																												
New Class 387/3 EMUs (32 cars)	10/2016	11/2016																																											
Other EMUs for Thames Valley Electrification (200 cars)	4/2016	3/2017																																											
GW New Class 800/801 IEP trains (369 cars)	5/2017	7/2018																																											
GW New Class 802 trains (173 cars)	5/2018	12/2018																																											
GW Electrification, Maidenhead-Didcot		12/2017																																											
GW Electrification, Didcot-Cardiff		12/2018																																												
GW Electrification, Reading-Newbury		12/2018																																												
GW Electrification, Thames branches		12/2018																																												
GW Electrification, Parkway to Bristol TM		7/2019																																												
GW Electrification, Didcot-Oxford		12/2019																																												
'GW Electrification, Swindon – Bristol via Bath		4/2020																																											
GW Electrification, Cardiff-Swansea		CP6																																												
GW Electrification, Reading-Basingstoke		CP6																																												
25kV Electrification, Basingstoke-Southampton		CP6																																												
Western Rail Access to Heathrow		CP6																																												
VTWC Franchise STA	11/2014	4/2018																																												
ICWC New Franchise	4/2018																																												
VTEC New Franchise	3/2015	3/2023																																												
ICEC New Class 800/801 IEP trains, Phase 1 (227 cars)	8/2018	4/2019																																											
ICEC New Class 800/801 IEP trains, Phase 2 (270 cars)	5/2019	2/2020																																											
EMT Franchise STA	10/2015	3/2018																																											
EM New Franchise	3/2018																																												
Rolling Stock for MML Phase 1 Electrification	tbc	tbc																																											
MML Electrification, Bedford-Corby		12/2019																																												
Rolling Stock for MML Phases 2&3 Electrification	tbc	tbc																																											
MML Electrification, Derby, Nottingham, Sheffield		12/2023																																											
XC Franchise STAs	10/2016	10/2019																																												
XC New Franchise	10/2019																																												

Franchise STAs | New Franchises | Electrification Complete | Other Infrastructure Complete | Committed New Rolling Stock | Other Rolling Stock

Network Rail dates are as in the Enhancements Delivery Plan Update dated January 2016, quoting when infrastructure is planned to be authorised for passenger use

APPENDIX 3, TIMELINE OF KEY ACTIVITIES RELATING TO REGIONAL FRANCHISES

Item	Start	Finish
Northern Franchise STA	4/2014	4/2016
FTPE Franchise STA	4/2015	4/2016
ARN New Franchise	4/2016	4/2025
New EMUs and DMUs for Northern (281 cars)	12/2016	12/2018
FTPE New Franchise	4/2016	4/2023
FTPE New Class 350/4 EMUs (40 cars)	12/2013	3/2014
New trains for FTPE (c.220 cars)	12/2017	12/2019
NW Electrification, Liverpool-Earlstown/Wigan		3/2015
NW Electrification, Manchester-Ordsall Lane		4/2015
NW Electrification, Ordsall Lane-Preston		12/2017
NW Electrification, Manchester-Stalybridge		12/2017
NW Electrification, Preston to Blackpool		5/2018
NW Electrification, Guide Bridge-Stalybridge		12/2022
NW Electrification, Lostock-Wigan		CP6
NW Electrification, Oxenholme-Windermere		CP6
TPE Electrification, Leeds and York/Selby		12/2022
Northern Hub Capacity	12/2017	12/2019
Merseyrail Franchise	7/2003	7/2028
New EMUs for Merseyrail	tbc	tbc
ScotRail New Franchise	4/2015	4/2022
Caledonian Sleeper Franchise	4/2015	4/2030
ScotRail Electrification, Rutherglen to Whifflet		9/2014
Borders Railway Reopening		9/2015
ScotRail Electrification, Cumbernauld-Greenhill		3/2017
Caledonian Sleeper, New Rolling Stock (75 cars)	6/2018	6/2019
Edinburgh-Glasgow Electrification, Initial Service		3/2017
Edinburgh-Glasgow Electrification, 8x23m trains		3/2019
ScotRail Electrification, Alloa, Dunblane, Shotts		3/2019
ScotRail, New Class 385 EMUs (234 cars)	9/2017	11/2018
LMR New Class 350/3 EMUs (40 cars)	10/2014	8/2015
LMR Franchise STA	4/2016	10/2017
WM New Franchise	10/2017	
Barnt Green - Bromsgrove Electrification		4/2017
Walsall - Rugeley Electrification		12/2017
W&B New Franchise	10/2018	
EMUs for Valleys Electrification		tbc
South Wales Valleys Electrification		tbc



Franchise STAs | New Franchises | Electrification Complete | Other Infrastructure Complete | Committed New Rolling Stock | Other Rolling Stock

Network Rail dates are as in the Enhancements Delivery Plan Update dated January 2016, quoting when infrastructure is planned to be authorised for passenger use

APPENDIX 4, CATEGORISATION OF ROLLING STOCK TYPES

For the purpose of this Rolling Stock Strategy, existing and committed rolling stock classes have been allocated to the generic rolling stock Types A to G as shown in the following table.

Type A (Shorter Distance Self-Powered)	Type B (Middle Distance Self-Powered)	Type C (Longer Distance Self-Powered)	Type D (Shorter Distance Electric)	Type E (Middle Distance Electric)	Type F (Longer Distance Electric)	Type G (Very High Speed Electric)
121	158	180	313	317	390	395
139	159	220	314	318	IC225	
142	166	221	315	319	800	
143	168	222	345	320	801	
144	170	HST	357/3	321	802	
150	171		376	322		
153	172		378	323		
155	175		455	331		
156	185		456	332		
165	195		465	333		
			466	334		
			507	350		
			508	357		
			707	360		
				365		
				375		
				377		
				379		
				380		
				385		
				387		
				442		
				444		
				450		
				458		
				700		

Unpowered day coaches and the associated locomotives have been allocated to Types B and F as appropriate.

Sleeping cars and the associated locomotives and day coaches have been allocated to Types C and F as appropriate.

See also paragraphs 16 and 17 of the RSS.

APPENDIX 5, COMMITTED ROLLING STOCK FOR DELIVERY IN CP5 AND CP6

New rolling stock ordered or committed for delivery in CP5 and the early years of CP6 comprises the following:

Route and Vehicle Class or Type	No. of New Vehicles		Comments and Notes
	CP5	CP6	
Major DfT/ TfL Procurements			
Crossrail Class 345	504	90	**Ordered (1), (2)**
GWML IEP Class 800/ 801	369		**Ordered**
ECML IEP Class 800/801	227	270	**Ordered (1)**
Thameslink Class 700	1,140		**Ordered**
Subtotal, Major Procurements	**2,240**	**360**	
Other			
Caledonian Sleepers vehicles	75		**Ordered**
c2c, Type E EMU	0	68	
Gatwick Express Class 387/2	108		**Ordered**
Great Western, Class 387/3	32		**Ordered**
Porterbrook, Class 387/4	80		**Ordered**
Great Western, Class 802	173		**Ordered**
LOROL, Class 378	57		**Delivered (3)**
LMR Class 350	40		**Delivered**
Moorgate Type D EMU	150		**ITT Issued**
ScotRail Class 385	234		**Ordered (4)**
SWT Class 707	150		**Ordered**
TfL, Type D EMU	180		**Ordered (5)**
Thameslink Class 387/1	116		**Delivered (6)**
ARN Class 195 Type B DMU	79	61	**Ordered**
ARN Class 331 Type E EMU	66	75	**Ordered**
FTPE Electric and Bi-mode	80	140	**(7)**
Subtotal, Other	**1,620**	**344**	
TOTALS	**3,860**	**704**	

Notes
(1) The split of quantities to be delivered in CP5 and CP6 respectively is based on current plans.
(2) Includes a first additional 9-car train from the options included in the contract.
(3) Has extended all Class 378 units from 4-car to 5-car length.
(4) A further 30 vehicles will be delivered in CP6 if the franchise is extended to a 10-year term.
(5) For West Anglia and Gospel Oak – Barking services etc.
(6) This fleet will be transferred to other TOCs from December 2016.
(7) Dates and mix of trains to be confirmed

Other contract options and speculative requirements (e.g. new non-electric vehicles, and new electric vehicles for other routes being electrified) are not shown in this table.

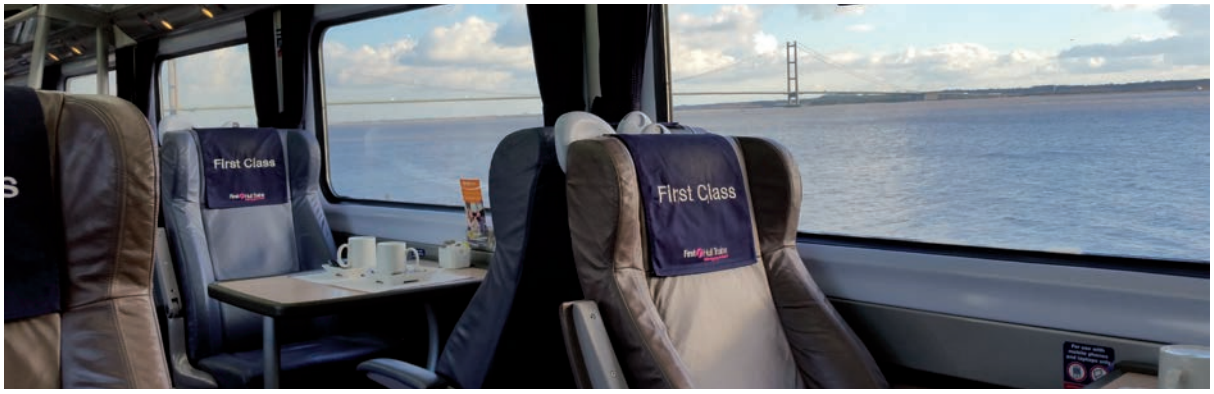
GLOSSARY

AC	Alternating Current
AGA	The Abellio Greater Anglia TOC
ARN	The Arriva Rail North TOC
ATOC	Association of Train Operating Companies
ATW	The Arriva Trains Wales TOC
BIS	Department of Business, Innovation and Skills
Bowe Report	The report by Dame Colette Bowe into the planning of Network Rail's CP5 enhancements programme
BR	British Rail
CP	A five-year regulatory Control Period
CP4	1/4/2009 to 31/3/2014
CP5	1/4/2014 to 31/3/2019
CP6	1/4/2019 to 31/3/2024
CP7	1/4/2024 to 31/3/2029
CP8	1/4/2029 to 31/3/2034
CP10	1/4/2039 to 31/3/2044
c2c	The TOC which operates the Essex Thameside franchise
DC	Direct Current
DfT	Department for Transport
DMU	Diesel Multiple Unit
DPI	Delay per Incident
DSSG	The Depots and Stabling Steering Group
EA	The East Anglia Franchise
EC	European Commission
ECML	The East Coast Main Line
EGIP	The Edinburgh – Glasgow Improvement Project
EMT	The East Midlands Trains TOC
EMU	Electric Multiple Unit
ERTMS	European Rail Traffic Management System
ETCS	European Train Control System
EU	European Union
FGW	The First Great Western TOC
FTPE	The First TransPennine Express TOC
Future Railway	A collaboration of Network Rail and RSSB, to accelerate research and innovation
GE	Great Eastern
GTR	GoVia Thameslink Railway
GW	The Great Western Franchise
GWML	Great Western Main Line
GWR	The Great Western Railway TOC
Hendy Report	The report prepared by Sir Peter Hendy and published in November 2015 regarding the timing and cost of infrastructure enhancements originally included in the HLOS for CP5.

GLOSSARY

HLOS	High Level Output Specification (expected in future to be re-named as the Rail Investment Strategy)
HST	InterCity 125 High Speed Train
HS1	The High Speed line from London to the Channel Tunnel
HS2	The proposed High Speed line from London to Birmingham, Manchester and Leeds
ICEC	The Intercity East Coast franchise
ICWC	The Intercity West Coast franchise
IC225	The intercity electric trains operated by the East Coast TOC
IEP	The Intercity Express Programme (and 'Super Express Trains' to be built by Hitachi)
IIP	Initial Industry Plan (expected in future to be re-named)
IPEMU	Independently Powered EMU
ISBP	Industry Strategic Business Plan
ITT	Invitation to Tender
kV	Kilovolts
KPI	Key Performance Indicator
L&SE	London and the South East
LMR	The London Midland TOC
LNW	Network Rail's London North Western Route
LTPP	The rail industry's Long Term Planning Process
LOROL	London Overground Rail Operations Ltd.
LUL	London Underground Ltd.
MAA	Moving Annual Average
Mark 1	20-metre slam-door rolling stock built by BR, now all withdrawn
Mark 2	Later 20-metre slam-door rolling stock built by BR, now almost all withdrawn
Mark 3	23-metre rolling stock built by BR, built from the mid-1970s and still in operation
Mark 4	Rolling stock operating in the IC225 trains
MML	Midland Main Line
MP	Member of Parliament
MTIN	Miles per Technical TRUST Incident
NFRIP	National Fleet Reliability Improvement Programme (now called 'ReFocus')
Northern Hub	Infrastructure capacity enhancements in the Manchester area
NRPS	National Rail Passenger Survey
NSAR	The National Skills Academy for Rail
NTAR	National Training Academy for Rail
NTF	The National Task Force for the punctuality of the rail network
NTPE	The North TransPennine route to be electrified from Manchester to Leeds etc.
NW	North West
ONS	Office of National Statistics
ORR	Office of Rail and Road
PRM-TSI	Technical Specification for Interoperability, for Passengers of Reduced Mobility
R&D	Research & Development
RDG	Rail Delivery Group
RIA	Railway Industry Association

ROSCO	A company that owns and leases rolling stock
RPI	Retail Price Index
RSG	The Rail Supply Group
RSS	The Long Term Passenger Rolling Stock Strategy
RSSB	The Rail Safety and Standards Board
RSSSG	Rolling Stock Strategy Steering Group (see paragraph 1)
RTS	Rail Technical Strategy
RUS	Route Utilisation Strategy
SD Principles	The ten Sustainable Development Principles adopted by the railway industry
SE	The South Eastern TOC and Franchise
SoFA	Statement of Funds Available
STA	Single Tender Action i.e. a short franchise awarded to an incumbent TOC
STM	A single track mile (e.g. of electrification)
SW	The South Western Franchise
SWT	The South West Trains TOC
TfL	Transport for London
TOC	Train Operating Company
TPE	The TransPennine Express franchise
TRUST	The Network Rail computer system used for monitoring trains and tracking delays
TSI	Technical Specification for Interoperability
TSLG	The Technical Strategy Leadership Group, who produce the Rail Technical Strategy
UK	United Kingdom
VfM	Value for Money
V/S SIC	Vehicle/ Structures Systems Interface Committee
VTEC	The Virgin Trains East Coast TOC
VTWC	The Virgin Trains West Coast TOC
VTISM	Vehicle Track Interaction Strategic Model
V/T SIC	Vehicle/ Track Systems Interface Committee
V/V SIC	Vehicle/ Vehicle Systems Interface Committee
W&B	The Wales and Borders Franchise
WM	The West Midlands Franchise
XC	The CrossCountry TOC and Franchise



Interior of an Alstom First Hull Trains Class 180 Type C 'Adelante' DMU introduced in 2000

A Bombardier Type E Class 387/2 'Electrostar' EMU under construction at Derby Litchurch Lane Works for introduction on GoVia's Gatwick Express services in 2016