Long Term Passenger Rolling Stock Strategy for the Rail Industry

Third Edition, February 2015

EVERSHOLT RAIL GROUP

angel Trains

porterbrook

Rail Delivery Group

This Long Term Passenger Rolling Stock Strategy has been produced by a Steering Group chaired by Richard Brown, and 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

Now in its third edition, it incorporates input from train builders, the Railway Industry Association, and other stakeholders.

Cover Photos:
A BR-procured Arriva Trains Wales Type A Class 150 DMU of 1986; a Siemens SWT Type E Class 450 'Desiro' EMU introduced in 2002; and a Hitachi Southeastern Type G Class 395 'Javelin' EMU of 2006

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

I would like to thank the rail industry for this most recent update of the Long Term Passenger Rolling Stock Strategy.

I am pleased to see how it has developed since the first edition was published in February 2013. It is now well established as a key element in the industry's Long Term Planning Process and provides a coherent road map for all those who are involved with the improvement and expansion of the railway network and its train services.

Since 2004, the UK has seen the largest growth in the number of rail passenger journeys in Europe. We are moving more people to more places than ever before – passengers who expect ever-higher levels of reliability, comfort and services such as Wi-Fi. This incredible growth brings many challenges, but is being matched by a level of investment in railway infrastructure and new trains that is without precedent in recent times. We know that we are playing catch-up, with an ever-increasing number of passengers travelling on fleets which will continue to require refurbishment and renewal. It is absolutely vital that investment in rolling stock keeps pace with this Government's massive investment in track and infrastructure. In addition to the benefits for passengers, this will produce a major potential benefit for the economy and will open up export opportunities for railway vehicles, equipment and expertise.

It is also good to see tangible evidence of steps to grow the numbers and skills of the rail engineering workforce, with the construction of the National Training Academy for Rail at Northampton, and the National College for High Speed Rail in Birmingham and Doncaster. It can truly be said that there has never been a better time to seek employment in the rail industry.

The future is bright, and the committed construction of large fleets of innovative trains will bring many benefits for passengers, the economy and the environment.

Claire Perry MP

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A BR-procured Northern Rail Type A Class 142 'Pacer' DMU introduced in 1985

Executive Summary

This is the third edition of the Long Term Passenger Rolling Stock Strategy (RSS), first published in February 2013. 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. Produced by a pan-industry group comprising vehicle owners, operators and maintainers, Network Rail and the Rail Delivery Group, it has been welcomed by government, investors, and other stakeholders.

The analysis is based on the medium term and long term forecasts of peak period passenger demand that are used for rail industry planning purposes and are recognised by government. Over the next 2-3 years the RSS will become increasingly focused on providing inputs to the industry-wide planning process for the five-year regulatory Control Period commencing in April 2019 (CP6).

In the previous edition of the RSS we expressed some concerns about the present need to let short contracts with some existing franchisees, and about the limitations on the DfT's operating expenditure budget. It is now clear, however, that these factors are not preventing longer term considerations (such as the benefits of improved quality and efficiency produced by new trains) from influencing investment decisions. The number of new electric vehicles committed for delivery in the five-year period that commenced in April 2014 (CP5) and in the early years of CP6 has continued to rise, and is now approaching 3,800. This represents a capital cost of more than £6 billion, at an average build rate of 12 vehicles per week, compared with an average of just four vehicles per week in the five years of CP4. Vehicle owners and train operators have also become increasingly innovative at adapting and extending the lives of older vehicles.

The total net increase in fleet size is forecast to be lower in CP6 than in CP5, following completion of the very large orders for the Thameslink, Crossrail and IEP projects. Britain's rail industry and its suppliers have several times experienced large fluctuations of demand for new vehicles and other equipment, and it is important that this is avoided so far as possible in future if the confidence of investors and the supply chain is to be increased. This would be helped by early Government commitment to a specific programme of electrification for CP6.

Some new and additional non-electric vehicles will be required in CP5 and early in CP6, as a result of:

- the existing levels of crowding and continuing strong growth of passenger demand on some non-electrified routes;
- the assumed replacement of the 'Pacer' vehicles; and
- the rate of completion of the committed programme of electrification.

The short-term requirement for additional non-electric vehicles is forecast to be in the range of 350 to 500 vehicles.

The longer term conclusions of the RSS are largely unchanged however. Peak and off-peak passenger growth across all market segments is forecast to continue and it will be necessary to expand the rolling stock fleet to avoid crowding. The total passenger fleet is forecast to grow by between 52% in the 'Low' scenario and 99% in the 'High' scenario over the next 30 years, and the proportion of vehicles that will use electric traction is forecast to rise from 69% today to over 90% by 2029 in all scenarios. The analysis indicates that between 13,000 and 19,000 new electric vehicles will be required over the 30 years to 2044. Electrification will in many cases permit longer trains, and will enable diesel trains to be transferred to non-electrified routes, where growth has been constrained by lack of sufficient vehicles. The modelling of electrification and growth demonstrates a reduction in rolling stock unit costs of more than 30% in all scenarios. The strategy emphasises the resulting benefits to passengers, including improvements to punctuality and reliability.

A.Introduction – Goals and Scope

1. This is the third annual edition of the Long Term Passenger Rolling Stock Strategy (RSS). The production of the first edition of the RSS in February 2013 marked the first time since privatisation that the industry had committed to develop a collaborative, industry-led strategy for passenger rolling stock. It was also the first time that the long term rolling stock implications of growth, electrification, HS2 and other major projects had been modelled and considered together. The work has been and is being 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 chaired by Richard Brown. RSSSG has in the last year taken over the work on rolling stock cost reduction opportunities in CP5 and CP6 which was being developed by RDG. Joint meetings between RSSSG and senior members of the Department for Transport (DfT) Rail Executive are held twice per year.

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 set out a number of proposals for delivering better value for money from rolling stock and was welcomed in the March 2012 Government Command Paper 'Reforming our Railways'. Among the recommendations of the Command Paper were that putting the TOCs and the ROSCOs, rather than DfT, in the lead for planning and delivering rolling stock through a market-based approach is the best way forward, and 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. RSSSG has been encouraged by ministerial endorsement of this approach.

3. The fundamental aim of the RSS is 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:
    - providing a backdrop for and an input to longer term planning, by train builders and their suppliers, ROSCOs, Network Rail and TOCs;
    - identifying opportunities to smooth peaks and troughs of workload;
    - highlighting priorities for further Value for Money (VfM) work;
    - facilitating a whole-system approach to strategy, bringing together infrastructure, demand growth, train services and fleet scenarios;
    - assisting investors to understand the longer term prospects and opportunities for the industry; and
    - identifying and analysing issues of concern for the medium and long term.

5. From the outset, the approach adopted for the RSS has principally been to work from the perspective of forecast growth in long term peak period passenger demand (i.e. as opposed to growth in total passenger miles) and its implications for each TOC and for different types of rolling stock. This in turn has enabled RSSSG to develop a number of scenarios for future fleet size. The emerging work has been discussed regularly with the train builders that are members of the Railway Industry Association (RIA), and this is continuing. RIA, the train builders and their suppliers have welcomed the creation of the RSS and its annual updates, and the RSS will be a key input to the Industrial Strategy and ongoing work of the newly-formed Rail Supply Group (RSG). The first edition of the RSS fed into the CP5 Industry Strategic Business Plans, for England & Wales, and for Scotland respectively, published in January 2013. The RSS is now established as an integral part of the industry's Long Term Planning Process (LTPP). The LTPP was endorsed by the Office of Rail Regulation (ORR) in April 2012 and focuses principally on infrastructure requirements and also has a 30-year horizon. The combination of this RSS and the LTPP work – together with the plans for new high speed rail infrastructure, all to be regularly updated - will continue to provide the overall picture for rail development over the next thirty years. The RSS is now focussing increasingly on the inputs for CP6:
   - The Initial Industry Plans (IIPs, September 2016);
   - The High Level Output Specifications (HLOSs, June 2017); and
   - The Industry Strategic Business Plans (ISBPs, January 2018).

6. In the first RSS published in February 2013, RSSSG 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 were that:
   - the franchising model is the best mechanism to deliver value for money rail services;
   - 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.

7. In its second edition, published in February 2014, the RSS:
   - considered the implications of the then recently-announced changes to the franchising programme and the DfT's role in negotiating some new short franchises in the form of Single Tender Actions (STAs) with incumbent TOCs (see Section B on page 8);
   - updated and rolled forward the forecasts for the size and composition of the national passenger fleet to 2043 in the light of forecasts of peak passenger demand over 10 years and 30 years as included in the Market Studies published by Network Rail in October 2013 (see Sections D, G and H on pages 11, 19 and 22);
   - considered how standardisation of rolling stock, subsystems and/or their key outputs can help to optimise route capacity and provide other benefits (see Section J on page 28); and
   - produced a high level estimate of incremental depot and berthing requirements that will be required over 10-year and 30-year horizons, as an input to the LTPP (see Section K on page 30);
   - summarised the key dates relating to franchising, electrification and other infrastructure enhancements, deliveries of new rolling stock and other significant rolling stock enhancements in a series of Timeline charts (see Appendices 1 to 3).

These and the other sections of the RSS have all now been refreshed and updated as necessary in the light of new information. The principal new material and assumptions contained in this third edition of the RSS are summarised in Section B on the next page.

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

8. In the February 2014 RSS we expressed concern that two of the first three new franchises then being let in England and Wales were heavily shaped by the large centrally-procured contracts for the Intercity Express Programme (IEP) and the trains for the Thameslink project respectively; and that the scope for adopting the principles of paragraph 6 above might be further curtailed by the DfT's need to negotiate STAs with some existing franchisees, limitations on the DfT's operating expenditure budget, and the need for the DfT to rebuild its rail resources and capabilities.

9. 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.

10. 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 medium term budget constraints should not be made at the expense of whole-life, whole-system value. (For example, the business case for some enhancements such as re-tractioning for some older fleets would become progressively weaker, the longer that they were deferred); and
    - the need for short term action should not constrain competitive tension and innovation.

11. RSSSG undertook a constructive dialogue with the DfT on these issues. We are pleased to report the strong evidence that the DfT (and Transport Scotland and Transport for London (TfL)) do indeed understand the longer-term opportunities to secure value for money from rolling stock. In particular it will be noted that our forecasts contained in Section H on page 22 of the quantities of new rolling stock to be delivered in CP5 and CP6 have been significantly increased by the confirmation of additional orders for new trains for the new Essex Thameside, Thameslink (for Gatwick Express and Moorgate services), ScotRail and Caledonian Sleepers franchises, the South West Trains (SWT) TOC, and the London Overground concession. A material factor here has been the inclusion in franchise ITTs and in franchise bid evaluation criteria for credit to be given for incremental quality to be delivered, and in some cases for benefits to be delivered beyond the life of the franchise.

12. The increased emphasis on credit being given for quality to be delivered by franchises and concessions, which RSSSG totally supports, together with continuing high levels of growth in peak period passenger demand and concerns about the pace of completion for the committed electrification projects, has made it certain that some additional non-electric rolling stock will be required in CP5. This is discussed in Sections E, F, G and H on pages 14 to 24.

13. A new section I has been added on pages 25 to 27. This emphasises the customer benefits of the RSS, including improvements in punctuality to be produced by growth in fleet reliability.

14. Against this background, the analysis undertaken for the February 2014 RSS has been reviewed and rolled forward to 2044. The long term conclusions about the size and composition of the fleet are largely unchanged, being demand-led and based on a range of assumptions and scenarios for growth in peak passenger demand and for future railway electrification.

C. The Approach Adopted for the Strategy

15. Scenarios for fleet size have been modelled by five-yearly Control Period for the whole of the 'main line' passenger fleet including Scotland, London Overground, Crossrail, and HS2 but not the light rail, tram-train, LUL, or international fleets.

16. 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 115 or 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).

17. 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 in no sense 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 at the time.

18. To develop these scenarios, we started with expectations for growth in peak period passenger demand, using the long term forecasts contained in the Route Utilisation Strategies (RUSs) published by Network Rail in 2011. These forecasts were consistent with those in the ISBPs published in January 2013. As outlined in Section D on page 12, we subsequently tested our projections using forecasts of peak period passenger demand over ten years and 30 years as included in the Market Studies published by Network Rail in October 2013. We then incorporated the effect of electrification scenarios by examining the various options listed in the 2009 Electrification RUS and prioritising these. To do this, we drew on the methodology used in that RUS and concentrated principally (but not solely) on those route sections where electrification would permit more efficient operation of passenger trains.

19. Using these inputs, three composite scenarios were defined and modelled as follows.
    - 'Low' - Low growth combined with a good level of capacity utilisation efficiency growth (this is the relationship between peak passenger demand growth and fleet size growth, see paragraphs 25 and 29 below) and a low level of future electrification.
    - 'Medium' - Medium growth combined with a medium level of capacity utilisation efficiency growth and a medium level of future electrification.
    - High' - High growth combined with a poor level of capacity utilisation efficiency growth and a high level of future electrification.

20. At the heart of the RSS, and facilitating its future updating, is a spreadsheet model. The RUS-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 has been determined for each of the three composite scenarios in the year 2044, and the implications for each of Control Periods CP5 to CP8 have then been determined by working backwards from that date.

21. These forecasts and scenarios for long term peak period passenger demand growth, fleet utilisation efficiency growth and electrification cannot, of course, quantify unpredictable external factors (e.g. energy shortages), or options for future government policy e.g. in relation to fares policy, investment in rail infrastructure, policies on crowding, road pricing etc. The RSS has taken some 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 third edition of the RSS, the intention is that RSSSG will continue to update the RSS to reflect industry and external developments including the franchising programme and emerging government policy.

22. The electrification programmes considered and modelled are illustrative. Since publication of the first edition of the RSS in February 2013, Network Rail has also undertaken an update of the Electrification RUS that was published in 2009 - see Section E on page 14. This will be published for consultation in the very near future. Network Rail has also published more details of the CP5 infrastructure enhancements programme through its CP5 Enhancements Delivery Plan. This is updated every three months, as more detail of scope and milestones become available for each significant project. When the CP5 Enhancements Delivery Plan was first published, many of the projects (about £7bn out of £12.4bn) were at an early stage of development, with high degrees of uncertainty and risk. This made it difficult for the ORR to determine efficient levels of funding. The ORR has therefore set up the Enhancements Cost Adjustment Mechanism (ECAM) to determine the levels of funding required when a single option has been identified for each project.

23. The 2011 RUSs contain, and the new Route Studies will update, many route-specific infrastructure and timetable options for increasing capacity over the next five to 30 years. Some of the presently committed enhancements including the 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 to be included in the Route Studies would 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 help find 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. Further information about incremental infrastructure, maintenance depots and berthing capacity is contained in Section K on page 30.

An Alstom Virgin West Coast Type F Class 390 ‘Pendolino’ train introduced in 2001

D. Planning for Growth – Sources of the Assumptions Adopted

24. Total passenger miles grew by 106% in the 19 years between 1994 and 2013, an average compound rate per year of 3.9%. (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 Europe. (See 'Growth and Prosperity' published by ATOC in July 2013). This indicates that the rail industry has successfully increased volumes through actions such as capacity improvement, marketing and new trains. This generates more revenue, which helps pay for the very substantial investment programme that the industry is undertaking in CP5. The same opportunity exists in future to help pay for capacity improvement.

25. To assess the implications for the number of vehicles needed in the future, we examined the long term relationship between demand and passenger fleet size. The 106% increase in passenger miles to 2013 was achieved with an increase of just 11% in the total national passenger fleet size. This major increase in fleet utilisation efficiency since privatisation has been achieved by much improved marketing and utilisation of spare off-peak capacity, and has been assisted by the following factors:
    - Replacement of Mark 1 EMUs and 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;
    - 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);
    - Achievement of higher levels of fleet availability, and of higher average train speeds on some routes;
    - Introduction of automatic passenger load weighing and counting technology on many fleets (which has led to more efficient utilisation of rolling stock).

    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.

26. The forecasting methodology adopted for the RUSs 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 1.5% per year, while the average for ten regional cities in England and Wales has been 2.6% per year. (Source: DfT data).

27. The fleet size growth forecasts in the Medium scenario of the RSS are based directly on the route-specific forecasts of long term growth in peak period rail passenger demand that are included in the 2011 RUS documents, extrapolated to 2044. In the case of peak flows to and from London, the L&SE RUS methodology has the merit of taking account of present levels of peak crowding.

28. The Low and High growth forecasts represent a range of possible outcomes for future rolling stock capacity requirements. For all routes, these Low and High forecasts of future fleet capacity have been modelled as 0.7 and 1.3 respectively (i.e. ± 30%) of the Medium forecast of the required fleet capacity in 2044, this being judged to be a reasonable range of likely outcomes making allowance both for uncertainties in future peak period passenger demand growth and in future capacity utilisation efficiencies.

29. Growth in peak demand of higher than the Medium case may occur, as each additional (presently uncommitted) future route enhancement or service enhancement may itself produce some 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 fleet availability or fleet utilisation). This would 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 25 above. The easiest of such opportunities have already been implemented, but more can be achieved through the effective specification and management of franchises. This can be facilitated by:
- continuing improvements in timetable patterns;
- introduction of more vehicles with 'metro'-style interiors for short-distance services for which the DfT has for some time permitted higher levels of standing, coupled with some greater route-specific flexibility in franchise specifications regarding standing in peak periods for middle distance services;
- introduction of new industry-wide metrics for and benchmarking of peak capacity utilisation, as an aid to effective management of capacity;
- changing the profile of peak demand; and
- replacement over time of many or most of the remaining trains formed of Mark 3 and Mark 4 rolling stock which have non-passenger carrying vehicles (locomotives, power cars and driving trailer vehicles).

30. Network Rail published three new Market Studies in October 2013, for the L&SE, Long-Distance and Regional Urban markets respectively which underpin the next five-year cycle of the LTPP. The peak period passenger demand forecasts contained in the Market Studies will form an input to the Route Studies being published by Network Rail over the next three years.

31. The Market Studies are important 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 demand forecasting methodology used in the Market Studies is very close to that used in the 2011 RUS documents. We have checked the range of 30-year forecasts contained in the Market Studies and have identified a high degree of consistency with the range of the national fleet size forecasts for 2044 as published in Table 3 of this RSS. A 'Conditional Output' specified in each of the Market Studies is to plan to accommodate the high growth scenario in passenger journeys forecast to occur by 2043. The Route Studies use the high growth scenario for each route or regional city contained in the Market Studies, as the basis for developing 30-year options for future infrastructure capacity on each route.

33. Additional data is provided in the Market Studies in the form of 10-year forecasts for peak passenger demand growth for all of the principal routes to London, for ten regional cities in England and Wales, and for all-day flows between pairs of 13 British cities. The degree of overall correlation with the RSS Table 3 figures for fleet sizes in 2024 is again good. As in the February 2014 RSS, this has provided a 10-year focus on future fleet sizes, as described in Sections G and H on pages 19 to 24.

34. We have also included estimates of fleet requirements for HS2 based on the latest available information from HS2 Ltd and discussions with them about options for growth after initial service introduction. We have adopted a wide range of assumptions in the three scenarios for the rolling stock volumes that will be required to operate high speed and intermediate services on the existing long-distance routes after capacity has been released by HS2.

The first Hitachi Type F Class 800 'Super Express Train', to be introduced on the Great Western and East Coast routes from 2017

E. Electrification – Prioritisation and Analysis

35. As outlined in this RSS, route 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.

36. The present total national Network Rail track mileage is 19,336 single track miles (excluding depots and sidings, referred to in this RSS as 'track miles' - source Network Rail Annual Return 2014). Of this, 8,008 track miles (41.4%) are electrified and 11,312 track miles (58.6%) are non-electrified. 64 track miles of new electrification were completed in 2013/14, in the North West of England and in Scotland. In the whole of CP4 there were 204 track miles of new electrification. Following the completion of around 1,850 track miles of electrification currently authorised, 51% of total track miles will be electrified. The currently assumed completion dates for all of the committed electrification schemes are shown in the Timelines contained in Appendices 1 to 3, based on Network Rail's CP5 Enhancements Delivery Plan published in December 2014.

37. Although the DfT cannot yet commit to a rolling programme of electrification beyond CP5, the direction of government policy is to continue such a programme into CP6 and beyond. Views were sought by the DfT on this in response to the 2012 HLOS. The formal response of Network Rail (supported by inputs from an industry-wide stakeholder group) will be contained in the update of the Electrification RUS, to be published for consultation in the near future. Separately an Electrification Task Force, led by MPs and Rail North with advice from Network Rail, will present the case for further electrification in the North of England. Transport Scotland's CP5 HLOS already contains a specific objective of a rolling programme of electrification amounting to approximately 60 single track miles per annum, following the completion of the Edinburgh to Glasgow Improvements Programme (EGIP) electrification.

38. The 2009 Electrification RUS listed 131 route sections as 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.

39. 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).

40. Taking account of this data, and the extent to which electrification would release good mid-life diesel units to increase capacity where needed on other non-electrified routes, and also taking some regard of the other ranking factors in paragraph 38 above, we produced an indicative ranking of route sections that might be electrified in CP6 and beyond (subject to business case development, affordability and negotiation of satisfactory commercial terms).

41. 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 timing and phasing of electrification of individual

routes have been considered in the updated Electrification RUS, and will be determined through the LTPP. 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 (% of Total Track Miles that might be Electrified by the end of CP8 in 2034)

	Low	Medium	High
% Electrified	62%	71%	77%

Source – Analysis based on data provided by Network Rail from the 2009 Electrification RUS

42. We have adopted the results from a sensitivity test on the 'Low' scenario of the RSS to illustrate what would be the consequences of a slower overall rate of electrification in CP5 through to CP7, pending the development of new assumptions once an electrification programme for CP6 is developed through the LTPP and is approved by government. Any reprogramming of the completion dates of the currently planned electrification projects would have adverse consequences as outlined in paragraph 70 below.

43. The analysis for the updated Electrification RUS has included appraisals of the business case for electrification of many routes. When finalised this will form an input to the IIP and to the next edition of the RSS. We are still some way from government underwriting a specific electrification programme for England and Wales in CP6 and beyond, but the scenarios contained in our own modelling for the RSS are consistent with the direction of government policy.

44. Conversion of DC-electrified routes to AC or to dual-voltage capability has been ignored for the purpose of this analysis. There is one such scheme that is being evaluated by Network Rail in CP5, this being between Basingstoke and Southampton as part of the 'Electric Spine' route. Such conversion here or elsewhere, if and where there is a business case, is likely to lead to replacement of existing BR-procured DC rolling stock and/or retrofit of existing post-privatisation EMUs. Given that examination of the business case for DC to AC conversion is still at an early stage, we have not made specific allowance for any replacement or modification of these fleets. Our analysis assumes that DC to AC conversion will not lead to an increase in total vehicle numbers beyond that which would be required for growth.

Artist's impression of Hitachi Type E AT200 EMUs, to be introduced on ScotRail from 2017

F. The Present Fleets and Future Capability Requirements

45. Details of the composition of all of the existing fleets (in use, rather than stored), and of committed changes to the end of March 2015, are summarised in Table 2 below, using the definitions in paragraphs 15 and 16 above. 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). These are not rigid categorisations. For example, some of the existing InterCity 125 (HST) Type C diesel trains that will be displaced by IEP trains or by electrification may be used on services currently operated by Middle Distance Type B DMUs if their operating characteristics are suitable and if there is a business case to do this. The committed transfer of HSTs to work in short formations on Scottish internal intercity services is one such example.

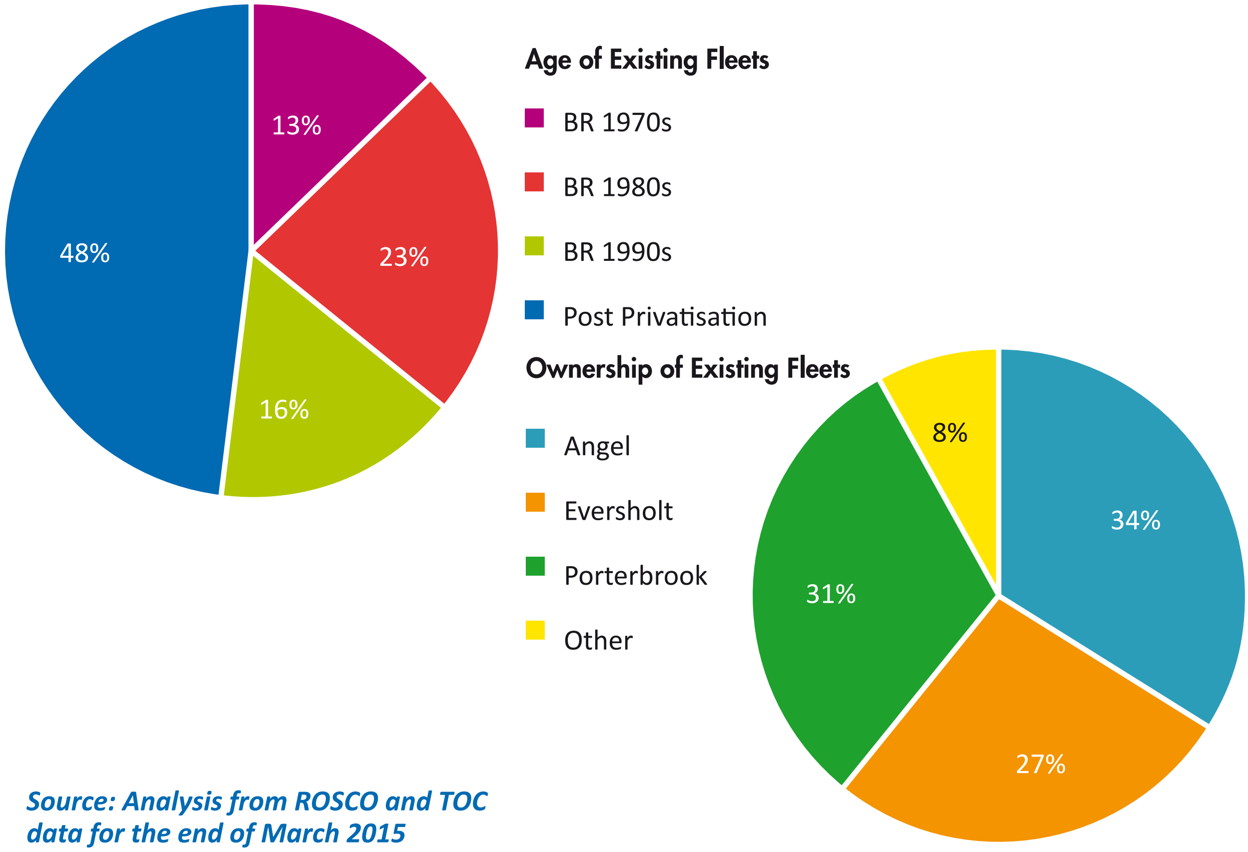
Table 2 – Present Fleet Composition (including Committed Changes to March 2015)

Generic Type	Total Vehicles, March 2015
A. Shorter Distance Self-Powered (diesel, generally with 75 mph maximum speed);	1,057
B. Middle Distance Self-Powered (diesel, with 90/ 100 mph capability);	1,357
C. Long Distance Self-Powered (diesel, with 100/ 110/ 125 mph capability);	1,495
D. Shorter Distance Electric (generally with 75 mph maximum speed);	2,366
E. Middle Distance Electric (with 90/ 100/ 110/ 115/ 125 mph capability);	5,178
F. Long Distance Electric (with 100/ 110/ 125/ 140 mph capability);	1,148
G. Very High Speed Electric (140 mph and above, for domestic services on HS1 and HS2).	174
TOTALS	12,775

Source: Analysis from ROSCO and ATOC data for the end of March 2015

46. Figure 1 on the next page shows that, of the 12,775 vehicles:
- 6,104 (48%) have been built since privatisation (i.e. in the last 18 years); and
- 1,023 (8%) are owned by parties other than the three largest ROSCOs (e.g Voyager Leasing), principally in categories C, D and E.

Figure 1 Present Age and Ownership of the National Passenger Rolling Stock Fleet



Source: Analysis from ROSCO and TOC data for the end of March 2015

47. 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 straight-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. Some electric units may in future include some form of electricity storage for operation away from overhead or third rail power sources, subject to a satisfactory business case and continuing development of power storage technology. The present 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). FutureRailway is organising a competition to encourage the development of novel technical solutions which can provide improved energy efficiency for self-powered vehicles (the 'Power Train Challenge'). Both FutureRailway 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 very low priority or business case for electrification.

48. It has been widely expected that present and future EU legislation regarding emissions from diesel engines (Directive 97/68/EC and its subsequent amendments, implemented in Great Britain as the Non-Road Mobile Machinery (Emission of Gaseous and Particulate Pollutants) Regulations 1999 and 2013, known as NRMM) will increasingly make it difficult to procure and operate new DMUs having underfloor diesel engines, with an affordable business case. Indeed, EU consultation on further tightening of the rules is now underway. Our present understanding of the associated issues 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.
- The NRMM 2013 Directive contains an Extended Flexibility Scheme which allows engines on existing trains to be replaced with new Stage IIIA compliant engines (rather than with the later standard Stage IIIB compliant engines). The only Stage IIIA compliant engine currently fitted to a British DMU is the MTU 1800 series engine fitted to the Class 172 DMUs built by Bombardier in 2010-11. No TOC or ROSCO has to date needed to consider whether this or any other Stage IIIA compliant engine might one day have to be fitted to any existing British DMU.
- It is probably 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 proposes to examine the feasibility, reliability and business case of fitting pairs of smaller Stage IIIB compliant automotive diesel engines beneath former LUL vehicles.

Further discussion of new-built or additional self-powered rolling stock being required in CP5 or CP6 is contained in Sections G and H on pages 19 to 24.

49. Some overlap is already occurring in the distinction between Categories E and F. On the south end of the West Coast Main Line, and on other principal electrified (and to be electrified) long distance main lines, maximum route capacity and revenues will most probably be achieved if high capacity, high performance electric trains (in some cases with a maximum speed of 110, 115 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. Trains with a top speed of more than 117 mph lose some passenger capacity because of the EC's Technical Specification for Interoperability (TSI) requirements relating to passengers in the leading vehicles of higher speed trains. (See Sections J and K pages 28 to 32).

Trial conversion of a Bombardier Greater Anglia Type E Class 379 'Electrostar' EMU of 2010 to be the first IPEMU

G. Fleet Sizes and Compositions Calculated for each Scenario

50. As described in paragraph 19 above, the three growth and capacity utilisation scenarios have been combined with three electrification scenarios to obtain three composite scenarios within the spreadsheet model, for each TOC, for each Control Period to 2044. The aggregated results are summarised in Table 3 on the next page.

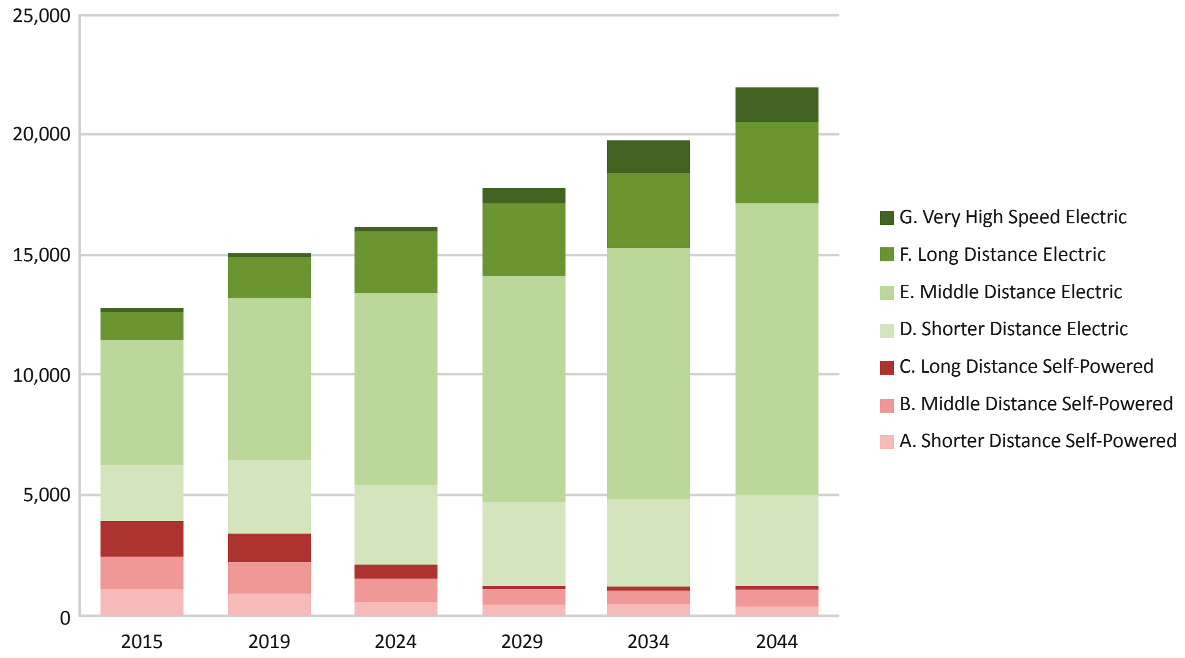
51. The key developments over 30 years highlighted in Table 3 are:
- an overall increase of 52-99% in the size of the total national passenger fleet;
- the electric fleets rising from 69% of the national fleet today to 92-95%; and
- the self-powered fleets falling from 31% of the national fleet today to 5-8%.

52. It can be deduced that in the Low scenario, a minimum of 13,000 new electric vehicles would be required by 2044, from today's base position. This figure comprises the sum of:
- 9,000 which is the net increase in electric vehicles over 30 years, in the Low scenario;
- 4,000 to replace most of the BR-procured electric fleets (all of which will be a minimum of 50 years old in 2044).

53. In the Medium and High scenarios, this minimum total of 13,000 new electric vehicles to be constructed by 2044 would rise to 16,000 and 19,000 respectively. This equates to a construction requirement for electric trains averaging approximately 8, 10 or 12 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.

54. The projected changes in the size and composition of the national passenger fleet for the Medium Scenario are shown in Figure 2.

Figure 2 – Changes in Fleet Size and Composition, 2015 - 2044 (Medium Scenario)



Source: Analysis as in Table 3.

Table 3 – Aggregated Results of Fleet Size Changes for the National Passenger Fleets to 2044 (Low, Medium and High Scenarios)

	Committed	Forecast CP5, March 2019			Forecast CP6, March 2024			Forecast CP7, March 2029			Forecast CP8, March 2034			Forecast 10, March 2044		
Sub-Group	Total Vehicles	Total Vehicles			Total Vehicles			Total Vehicles			Total Vehicles			Total Vehicles		
	March 2015	Low	Med.	High	Low	Med.	High	Low	Med.	High	Low	Med.	High	Low	Med.	High
A. Shorter Distance Self-Powered	1,057	879	850	913	701	535	557	462	432	411	451	405	356	437	371	301
B. Middle Distance Self-Powered	1,357	1,442	1,314	1,373	1,053	1,009	1,096	924	626	738	903	613	701	936	714	784
C. Long Distance Self-Powered	1,495	1,132	1,213	1,286	690	575	631	87	149	198	87	149	198	87	149	198
D. Shorter Distance Electric	2,366	2,953	3,074	3,100	3,232	3,307	3,383	3,294	3,476	3,648	3,448	3,638	3,874	3,534	3,823	4,105
E. Middle Distance Electric	5,178	6,442	6,729	6,837	7,560	7,972	8,171	8,548	9,443	10,134	9,291	10,548	11,730	10,227	12,060	13,795
F. Long Distance Electric & Bi-Mode	1,148	1,728	1,749	1,782	2,189	2,575	2,697	2,522	2,989	3,436	2,246	3,010	3,799	2,496	3,382	4,298
G. Very High Speed Electric	174	174	174	174	174	174	174	654	662	686	1,397	1,436	1,507	1,485	1,532	1,603
TOTALS	**12,775**	**14,750**	**15,103**	**15,465**	**15,599**	**16,146**	**16,709**	**16,491**	**17,776**	**19,250**	**17,823**	**19,799**	**22,164**	**19,202**	**22,031**	**25,084**
Effective Capacity Growth on October 2014	1%	17%	20%	22%	24%	28%	32%	31%	41%	52%	41%	57%	76%	52%	74%	99%
Self-Powered Totals	3,909	3,453	3,377	3,572	2,444	2,118	2,284	1,472	1,207	1,347	1,440	1,167	1,255	1,460	1,234	1,283
Electric & Bi-Mode Totals	8,866	11,297	11,726	11,893	13,155	14,028	14,424	15,018	16,569	17,903	16,382	18,632	20,909	17,742	20,797	23,801
Electric & Bi-Mode %	69%	77%	78%	77%	84%	87%	86%	91%	93%	93%	92%	94%	94%	92%	94%	95%

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

55. The current committed programme of electrification, if continued into CP6 and beyond, can produce a flow of mid-life DMUs for use on non-electrified routes, (subject to commercial terms). Based on the electrification scenarios in this RSS and the figures in Table 3 it had been assumed that there would be no requirement for any new or additional diesel or other self-powered rolling stock on a significant scale in CP5 or CP6 unless or until hybrid technology matures and the business case becomes sufficiently strong, or until such time as new environmental legislation makes the operation of the present diesel-engined vehicles non-viable (see paragraph 48). The February 2014 RSS stated that small orders of additional new self-powered vehicles might be required, however. This topic is developed further in Section H on page 22.

56. RSSSG has 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 implications of the RSS for the manufacturing and maintenance communities are clear and either directly or indirectly should have a positive impact. 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.

57. The train builders 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 RSS is now recognised as a key input to the Industrial Strategy to be developed by the recently established Rail Supply Group (RSG).

58. The train builders and RIA have emphasised their firm belief that:
- the procurement of new rolling stock is normally best undertaken by TOCs with ROSCOs;
- 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.

A Bombardier East Midlands Trains Type C Class 222 'Meridian' DMU introduced in 2004

H.Rolling Stock Requirements in CP5 and CP6

59. For the second edition and again for this third edition of the RSS, we felt it important to review the impact of our assumptions for the fleet over Control Periods CP5 and CP6, covering ten years. RSSSG had already checked the fleet size forecasts derived for 2019 for consistency with rolling stock analysis undertaken as an input to the Industry Strategic Business Plan (ISBP) for CP5 which was published in January 2013.

60. Section 5.2.6 of the ISBP for England & Wales (but containing in this instance rolling stock data for Scotland also) stated that the total of new vehicles in CP5 could be "up to 4,150", including a nominal 2,400 vehicles for Thameslink, Crossrail and IEP. The figure was expressed in this way to reflect a range of potential options, depending on which routes might best be able to make the business case for new vehicles as opposed to cascaded vehicles, and/or around the strength of the business case for enhancement or life extension of existing and cascaded vehicles.

61. RSSSG has continued to review the emerging intelligence on such business cases. The ISBP forecast of up to 4,150 new vehicles to be delivered in CP5 is still consistent with the High scenario of Table 3 of this RSS. The commitments for new vehicles contained in the winning bids for the recently let franchises has demonstrated the impact of credit being given by franchisors for incremental quality to be delivered, and in some cases for benefits to be delivered beyond the life of the franchise, as outlined in paragraph 11 above. This has altered the relative attractiveness of new vehicles compared with the continued operation and life extension of existing vehicles.

62. Our updated analysis of fleet sizes in CP5 and CP6 indicates that 1,109 new EMU vehicles are now committed for delivery in CP5 (for England, Wales and Scotland, and including TfL's rail concessions), in addition to 2,240 electric or bi-mode vehicles for the Thameslink, Crossrail and IEP projects to be delivered by the end of CP5. This makes a total of a minimum of 3,349 new electric or bi-mode vehicles to be delivered during this Control Period. This compares with a figure of 3,050 new electric or bi-mode vehicles in CP5 quoted in the February 2014 RSS. Orders have already been placed for 3,019 or 90% of this total of 3,349 vehicles. 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 428 vehicles for the Crossrail and IEP projects, and for the Essex Thameside franchise, have already been committed for delivery in the early years of CP6. The forecast delivery dates of committed rolling stock orders (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. A summary of the committed rolling stock that will be delivered in CP5 and CP6 is attached as Appendix 5.

63. The total number of new electric or bi-mode vehicles to be delivered in CP5 could yet rise further when new franchises are let if the efficiency, quality and capability of new electric trains can justify replacement of older electric trains. None of the present electric fleets has a fixed or absolute technical life, however. 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.

64. Our updated fleet size forecasts contained in Table 3 of this RSS show the 'Electric and Bi-mode' fleet totals increasing by between 1,900 and 2,500 over the course of CP6, in the three scenarios. This compares with a forecast increase of between 2,500 and 3,100 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 highly likely 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.

65. The over-riding reason for this is that the Thameslink and Crossrail projects, and replacement of most of the 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. Even HS2 is forecast to require only around 500 new vehicles in CP7, with a further 700 to 800 in CP8.

66. This analysis illustrates that 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 direct 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, combined with an early commitment to a continuing programme of electrification, should provide a greater degree of predictability about orders for new electric vehicles beyond CP5. This can help manufacturers to optimise production capacity and associated costs.

67. The short, medium and long term requirements for new self-powered vehicles are more difficult to predict. 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 2044, 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 since privatisation, these being built between 1997 and 2011. Most of these could still be operating in 2044, if environmental legislation and the supply of engines permit this, and subject to commercial leasing terms. Based on the figures in Table 3, a total of between 1,200 and 1,500 self-powered vehicles will be required in 2044. As this is a similar total to the number of Type B and Type C self-powered vehicles built since privatisation, it is possible that relatively few new self-powered vehicles may be required to be built in the 30 years to 2044. Alternatively if environmental legislation were to be strengthened, then up to 1,500 new self-powered vehicles may be required. This is a small figure compared with the 13,000 to 19,000 new electric vehicles forecast to be required over this period.

68. RSSSG has undertaken some detailed analysis and sensitivity testing of the requirements for self-powered trains in recent months. This has included detailed analysis of the total number of Type A and Type B vehicles likely to be required in each year to 2022. This work has indicated a potential requirement for 350 to 500 additional non-electric vehicles, for a variety of urban stopping, rural stopping and inter-urban express services. This analysis assumes replacement of most or all of the 290 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 be satisfied by various permutations of new construction and/or conversion of older vehicles, including loco-haulage in some instances. Train builders, lessors and franchise bidders are examining the case for new construction. Concerns about how to 'future-proof' such an investment in new trains could be mitigated in various ways including:

- building the trains as bi-modes, 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; or
- incorporating energy storage from braking (though the development timescale for such new technology is likely to be too long for the immediate requirement).

69. Timescales are tight but RSSSG is confident that the industry (TOCs, manufacturers and leasing companies) can provide solutions to these issues in CP5 and early in CP6. It is probable that some manufacturers will be willing to develop new non-electric vehicles. Equally, 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.

70. Any delays to the planned electrification completion dates in CP5 and a slower rate of electrification thereafter as referred to in paragraph 42 above, 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 any new diesel vehicles (compared with new electric vehicles, see Section L on page 33);
- Incremental costs associated with short initial leases, subsequent transfer to other non-electrified routes, and residual value risks;
- Longer introduction timescales compared with those for new electric vehicles; and
- The lower reliability of diesel vehicles compared with electric vehicles (see Section I on page 27).

71. 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). Network Rail is currently evaluating the business case and affordability of accelerating implementation of ERTMS as part of its 'Digital Railway' proposal (see also paragraph 113). TOCs and fleet owners can potentially achieve whatever rate of fleet fitment is required to meet this programme, subject to careful management of fleet availability and system reliability issues. 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.

The first Siemens Type E Class 700 'Desiro City' EMU, to be introduced on the Thameslink routes from 2015

I. Customer Benefits and Fleet Reliability

72. This Rolling Stock Strategy, delivered in conjunction with a continuing programme of electrification and other enhancements through the LTPP, will produce many benefits for customers.

73. Our 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.

74. Electrification will produce many customer 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 and emissions.

75. Electrification can also provide new through journey opportunities and additional diversionary route capability.

76. While new builds of rolling stock produce a step change in the interior environment, focused internal refurbishment of existing rolling stock is also able to deliver a ‘new train feel’ very cost-effectively. Recent examples have also included conversion of 1st class vehicles to provide additional standard class capacity. The improved interior layout of the refurbished SWT Class 455s and other subsequent fleets with such metro-style interiors facilitate passenger entry and egress and reduce station dwell times. The wide inter-car gangways now provided on new shorter distance rolling stock are an example of how capacity can be increased while also providing improved perception of (and achievement of) passenger security.

77. Statutory requirements for on-train facilities for passengers with reduced mobility are being delivered (the PRM-TSI modifications).

78. 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 customers, both in normal operation and during disruption.

79. Fleet-related customer satisfaction is measured and monitored for all TOCs through the twice-yearly National Passenger Survey data. TOC-specific targets are built into franchise agreements.

80. Owners of existing rolling stock seek always to ensure that enhancements are targeted not only at the passenger-facing features such as interior environment and functionality, but also at the key drivers of reliability. Recent examples include:
    - Re-tractioning of Class 465 EMUs and similar planned programmes on Class 455, Class 321, Class 317 and other EMUs;
    - Enhancements to other reliability-critical systems such as passenger doors and increased on-board real-time system condition monitoring.

81. Punctuality and reliability have a very high priority for all customers. The reliability statistics for each TOC’s fleets and sub-fleets are compiled, monitored and compared by the rail industry using a form of benchmarking that was originally introduced as the National Fleet Reliability Improvement Programme (NFRIP) in 2001. The benchmarking and sharing of good practice continues as ‘ReFocus’. NFRIP created a 20-Point Plan to encourage best practice for fleet reliability and other associated rolling stock issues across the industry, and this Plan is regularly

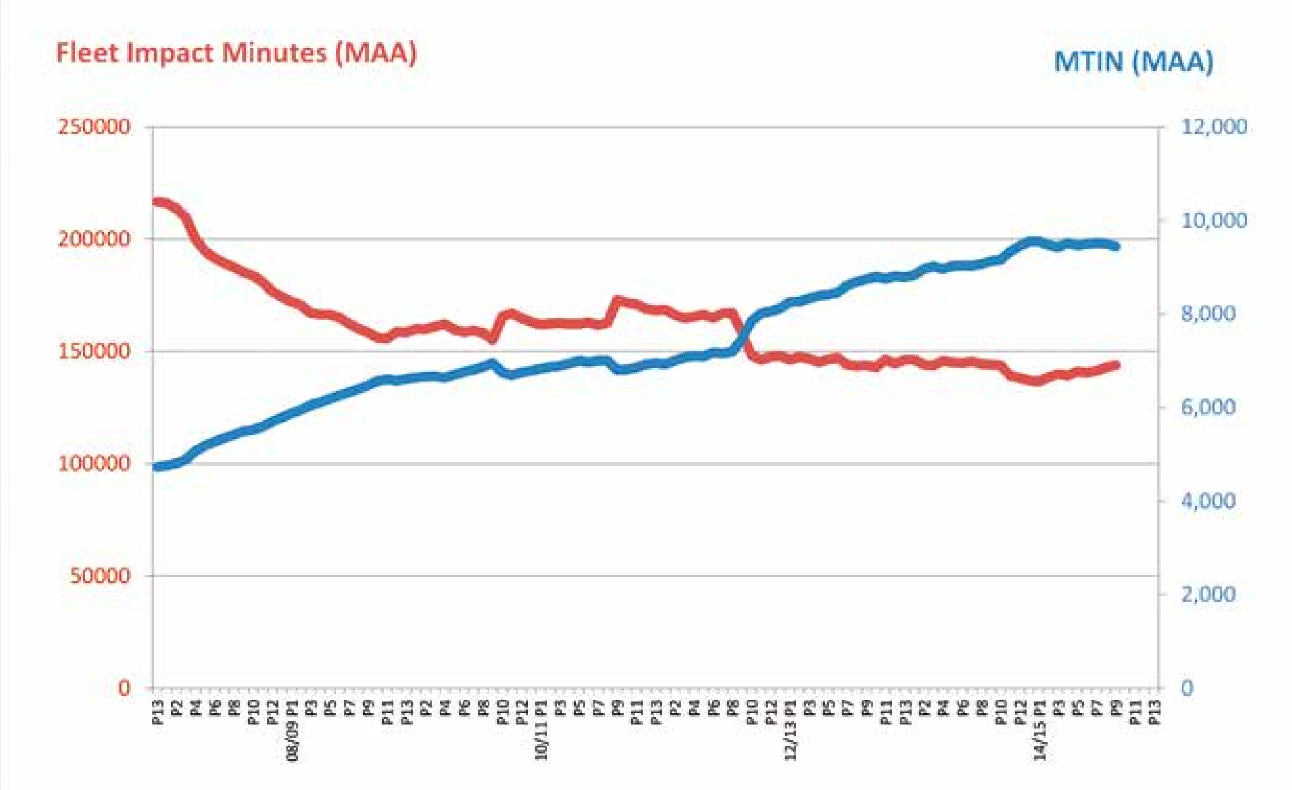
updated with input from vehicle owners, maintainers and operators. Progress is monitored closely by the industry's senior performance group, the National Task Force (NTF) and by owners, maintainers, builders and operators. Strategic direction is provided by NTF in setting the industry's national planned performance levels for punctuality and reliability.

82. 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.

83. 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.

84. The moving annual averages of total fleet-related impact minutes and of average MTIN are shown in Figure 3 for the period since March 2007.

Figure 3, Rolling Stock Reliability Growth since March 2007



Source: ATOC and Network Rail, as monitored by NTF

85. In Figure 3 it can be seen that:
- apart from during short periods of perturbation caused by extreme weather, the MAA of total fleet-related impact minutes has been falling steadily, and the MAA of miles per technical incident MTIN has been rising steadily;
- the MAA of fleet-related delay minutes has fallen by around one third. (It should be noted that annual timetabled passenger train miles have increased by 14% over this period);
- the MAA of average MTIN has improved by around 100%.

86. 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 9 of 2014/15 (i.e. November 2014) were as follows:

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

Fleet Class Group	MTIN MAA as at Period 9 2014/15
Modern EMU	36,097
Midlife EMU	16,586
Other Intercity	15,782
Modern DMU	14,671
Old Generation EMU	14,013
Midlife DMU	8,220
Old Generation DMU	6,636

Source: TOC Inputs to ATOC, used for ReFocus Benchmarking

87. In this Table 4 it can be seen that:
    - the 'Modern EMUs' have an MTIN MAA that is more than twice that of any other category of unit; and
    - the 'Old Generation DMUs' and 'Midlife DMUs' have significantly lower MTIN MAA.

88. Five of the '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; and
    - the inherent reliability of the traction systems of a modern EMU.

89. 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.

90. 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. This is independent of the many other initiatives that are being and will be developed to improve the reliability of existing fleets.

91. 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;
    - improvements to depot facilities;
    - collection of data to achieve better timetables and to enable improved interfaces with operations management.

92. There are however a number of risks to fleet reliability performance, in particular:
    - the possibility of slow reliability growth for the new fleets (potentially mitigated by expansion of test track facilities in Britain);
    - the risk of loss of reliability following the life-extension of older fleets or the transfer of fleets between TOCs; and
    - the risk that supporting infrastructure (depots and electrification) will not be commissioned in time for planned new fleet introductions or cascades, although the Twenty Point Plan contains good practice on fleet introduction and fleet cascade.

J.Standardisation Issues

93. 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) 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.

94. There are number of areas in which the industry – mostly with suppliers and manufacturers - is working together, in the UK and at EU level, to address this issue as a means of improving value for money. These are described in the following paragraphs 95 to 101.

95. 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. The guidance given covers the following areas:
- Technical;
- Performance and Environmental;
- Passenger Facing;
- Operational; and
- Communications and Diagnosis.

96. 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.

97. It is not always recognised that the operation of the normal commercial process in franchising, train procurement and leasing that was set up at privatisation has, in practice, naturally led to the evolution of several large families of train whose designs have continued to evolve, most particularly:
- Siemens' Desiro EMU (10% of the present national fleet);
- Bombardier's Electrostar EMU (18% of the present national fleet); and
- Bombardier's Turbostar DMU (4% of the present national fleet).

98. This has happened because, once a manufacturer has developed a train type and this has successfully been 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.

99. 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 densely-used 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.

100. **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 EC 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.

101. The industry is investigating, and implementing, ways of making more use of standardisation where this can be done without inhibiting the normal commercial process of train procurement and leasing that RSSSG regards is the linchpin to improving overall cost effectiveness in rolling stock provision. ATOC's policy document **'Rolling Stock and Value for Money',** published in December 2011 indicated that there may be opportunities to develop common interface approaches that the rail industry could, by way of guidance, use when procuring key subsystems. These could be of particular benefit where there is currently little competition, or to fill gaps in current industry standards that have been shown to cause reliability or customer satisfaction problems for train operators. ATOC is participating in a Europe-wide project named **'Euro-spec'** with train operators from France, Germany, the Netherlands, Denmark, Austria and Switzerland with ATOC representing British operators, developing output specifications for a number of systems and sub-systems. Those at present being developed include automatic couplers, wheels, brake discs and pantograph strips. Another item currently under consideration is train control management systems. The project will be presented and promoted to other European train operators at various conferences in 2015.

BR-procured Southeastern Type D Class 465 'Networker' EMUs introduced in 1991

K. Depot and Infrastructure Requirements

102. Plans for the additional maintenance depot capacity and berthing sites required for the large expansion of fleet sizes in CP5 are already well advanced.
   - Some new depots and berthing sites have already been constructed or adapted (e.g. Reading and Liverpool (Allerton) respectively).
   - The ORR has included a £312 million Depot and Stabling Fund for depot and stabling enhancements (e.g. for electrification schemes in England and Wales) in its determination of Network Rail's funding requirements in CP5.
   - The new and reconfigured depots and berthing locations required for the large new Thameslink, Crossrail, and IEP (GW and ICEC) fleets are already designed and committed, and construction is now well advanced in many cases.
   - The maintenance depot and stabling capacity that will be required for electrification and growth in Scotland is committed by Abellio as the new franchisee.
   - Options for depot and berthing capacity for EMUs in South Wales are being developed for the Welsh Government in discussion with the incumbent TOC and Network Rail.
   - Further work still needs to be done to appraise the optimum depot and berthing strategy for some of the routes to be electrified. Examples include the MML and NTPE routes.
   - A pan-industry Depot Strategy Steering Group has now been created. This group will coordinate bids for the Depot and Stabling Fund, and will quantify and prioritise longer term requirements, while accepting the principle that additional depot and stabling capacity should be franchise bidder-led wherever possible.

103. The requirements for increases in depot and berthing capacity in CP5 will be compensated in part by the reduced servicing and maintenance requirements of electric trains compared with diesel trains, and in some cases of new or re-tractioned electric trains compared with older electric trains. The business case for re-tractioning of SWT's Class 455 trains was assisted by quantification of the benefits generated by reduced scheduled maintenance, and the resulting release of depot capacity for fleet enlargement. Furthermore, the new depots being built for the Crossrail and IEP fleets will release some capacity for future fleet size expansion at locations such as Ilford and Bristol St. Philip's Marsh.

104. On the basis that plans for berthing and maintenance of the large increases in fleet sizes to the end of CP5 are now largely committed, we have carried out a preliminary analysis of the requirements for additional berthing to the end of CP6 in 2024, and then to 2044, for each of the 10 devolved Network Rail Routes plus HS2. This is based on the TOC-specific and in some cases route-specific analysis which underpins the spreadsheet model for the RSS. It takes no account of spare berthing capacity which may exist at some locations today, by day or by night.

105. The overall increases from 2019 to 2024 and from 2019 to 2044 are around 10% and 50% respectively in the Medium scenario. Apart from HS2 (for which plans for berthing and new maintenance depots are already being developed), the largest percentage increases are in the LNW and Western Routes and in Scotland. The growth percentages are driven principally by the forecast high increases in passenger demand for regional services.

106. The absolute forecast increases in berthing required over the next 30 years for L&SE routes are also large, because these routes have large absolute fleet sizes. 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 could be safeguarded for future depot and berthing uses in the longer-term, e.g. at Feltham. 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.

107. A critical factor not considered in this high level analysis 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', e.g. a 5-car unit could be introduced with the capability of being extended to a 6-car easily, provided that the depots and berthing sites have passive provision for the longer trains. 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.

108. 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.

109. 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 depots that are already known to pose significant operational constraints for one or more TOCs.

110. 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.
- Crossrail, Thameslink and IEP 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.

111. 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, and there is a risk that STAs will compound this further if the risk is not fully understood and acted upon. 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.

112. The National Skills Academy for Railway Engineering (NSARE) 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. 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) established by Siemens and NSARE, with support from the DfT and the Department of Business Innovation and Skills (BIS) for the rail industry at Northampton is a positive step forward and will be live from late 2015.
- HS2 Ltd is actively developing its requirements and proposed resources for skills training and for leadership training, to be located in particular at its National College for High Speed Rail sites in Birmingham and Doncaster.

113. 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 will be explored through the industry's LTPP over the next three years, and specifically through the next series of Route Studies, which potentially could identify solutions such as:

- 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 (see Section J on page 28);
  - the 'Digital Railway', including shorter headways between trains produced by changes to signalling, driver advisory systems, ERTMS, intelligent automated traffic management and centralised train control systems;
- incremental infrastructure – elimination of bottlenecks and provision of additional running lines; and
- totally new infrastructure.

114. Most of these solutions are already being adopted in the investment programmes now committed and being delivered for CP5. 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. the proposed 'Crossrail 2' scheme, and other major enhancements likely to include the GW Main Line and routes to the South Coast), where such investments may provide the only feasible solution, provided that they can demonstrate a robust long term business case.

FGW's new maintenance depot at Reading, opened in 2013 as part of the Reading Station Area Redevelopment capacity upgrade

L. Improving Value for Money from the Rolling Stock Fleets

115. In this Section L, the same base costs and price levels have been used as in Section G of the RSS published in February 2013 and in Section K of the RSS published in February 2014. New analysis has been undertaken as part of the update of the Electrification RUS (see Section E on pages 14 and 15 and specifically paragraph 43). When finalised, this will form an input into the next edition of the RSS.

116. According to the McNulty 'Rail Value for Money Study', the annual cost of maintenance and financing of rolling stock in the UK is £1.9 billion (at 2009/10 price levels), approximately 15% of total railway operating costs. The total cost of traction energy (electric power and diesel fuel) for the passenger TOCs has been estimated from ATOC data to be £0.55 billion. These costs totalling £2.45 billion p.a. are defined as Rolling Stock Related Base Costs in this Section.

117. The RSS will, as it develops, quantify many different kinds of opportunity by which costs can be reduced in the short term and over time. RSSSG is currently assessing 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, initially during CP5 and CP6.

118. The growth projections quantified in this RSS mean that a reduction in absolute costs is highly unlikely (given the likely increase in total fleet size), but taken together with the electrification scenarios there is significant scope to reduce unit costs for rolling stock, as outlined in this Section.

119. The requirement for subsidy per passenger mile can be reduced through this combination of growth, electrification and other changes, provided that the electrification projects are prioritised in respect of their business case, and taking account of incremental revenues and other benefits as well as incremental costs.

120. Typical rolling stock costs (i.e. total maintenance costs, and capital leasing costs) per vehicle-mile of diesel and electric vehicles are compared in Table 5:

Table 5 – Comparison of Diesel and Electric Rolling Stock Costs per Vehicle Mile

Cost per Vehicle Mile (£)	Diesel	Electric	Saving (£)	Saving (%)
Maintenance Cost	£0.80	£0.44	£0.36	45%
Capital Lease Cost	£1.43	£0.97	£0.47	32%
Maintenance and Leasing Costs Total	**£2.23**	**£1.41**	**£0.83**	**37%**

Source: TOC and ROSCO sources, for new EMU and DMU vehicles, assuming similar annual mileages, at February 2013 price levels

121. In general terms, the maintenance costs of diesel vehicles are 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.

122. 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 when financial and environmental factors are expected to increase the benefits of electrification as outlined in this RSS.

123. Other costs for diesel and electric vehicles are compared in Table 6:

Table 6 – Comparison of Other Diesel and Electric Costs per Vehicle Mile

Cost per Vehicle Mile	Diesel	Electric	Saving (£)	Saving (%)
Energy Cost	£0.47	£0.25	£0.22	47%
Track Maintenance Cost	£0.071	£0.068	£0.003	4%
Electrification Fixed Equipment Maintenance Cost	£0.00	£0.012	-£0.012	n/a
'Other Costs' Total	**£0.54**	**£0.33**	**£0.21**	**39%**

Source: TOC and ROSCO sources, for new EMU and DMU vehicles at February 2013 price levels

124. Future energy costs and the relative costs of diesel fuel and electricity are very difficult to forecast. Electricity costs are currently rising to help pay for lower carbon sources, while diesel fuel costs have fallen sharply. This factor, if it continued in the medium to long term, would have some impact on the business case for some electrification projects, but would not undermine the key conclusions of this RSS.

125. When the annual vehicle miles that might be electrified in each of the illustrative scenarios of this RSS are combined with the rolling stock related cost savings per vehicle mile from Tables 5 and 6, the gross rolling stock related savings that would result are as shown in Table 7:

Table 7 – Projected Annual Rolling Stock Related Cost Savings from Electrification, by 2044

Annual Rolling Stock Savings from Electrification	£ pa (millions)	% of Total Rolling Stock Related Costs
Annual Saving by 2044 **(Low Scenario)**	£346	14%
Annual Saving by 2044 **(Medium Scenario)**	£438	18%
Annual Saving by 2044 **(High Scenario)**	£479	20%

Notes: These savings have been calculated from the data in Tables 5 and 6 above, at February 2013 price levels. The annual savings have been presented as a % of the total annual Rolling Stock Related Base Costs for maintenance, capital lease and energy quoted in paragraph 116 above.

126. To get a fuller sense of the future impact on fleet unit costs, the savings in rolling stock related costs from electrification, and the costs of greater fleet sizes, have been combined with estimates of total increases in passenger miles to 2044. The results for the total national fleet are shown in Table 8 for the Medium scenario.

Table 8 – Estimated Reduction in Total Rolling Stock Related Unit Costs in 2044 (Medium Scenario)

	2011/12 (Base)	2044 (Medium Scenario)	Change
Rolling Stock Related Costs pa (£ millions)	£2,450	£3,500	44%
Passenger Miles p.a. (billions)	36	82	130%
Rolling Stock Related Costs (£ per thousand Passenger Miles)	£69	£43	-38%

Notes: The Rolling Stock Related Costs quoted for maintenance, leasing and energy in 2044 have been calculated as (Base Cost – RS Savings from Electrification (from Table 7)) x Increase in Fleet Size (from Table 3). The Passenger Miles quoted for 2044 have been conservatively assumed to be the 2011/12 actual (from ORR) plus 130%, this being derived from industry data increased for non-committed electrification and non-committed capacity enhancements after CP5, plus the impact of HS2, TOC marketing etc.

127. Similar analysis for the Low and High scenarios to 2044 produces a reduction in rolling stock related costs per thousand passenger miles of 41% and 35% respectively; and similar analysis for the Medium scenario to the end of CP6 in 2024 produces a saving of 21%.

128. Observations relating to Tables 5 to 8 are as follows.
- These estimated operating cost savings, though material, would not in general be sufficient on their own to justify the capital cost of electrification. The business case for electrification is generally founded on a combination of operating cost reductions, revenue increases, capacity benefits, carbon-related benefits and socio-economic benefits. Each such business case is route-specific.
- There is potentially a large range in the values of some of these estimates, affected by the type of service being electrified and the annual mileages of the fleets.
- It is difficult to be precise about the costs of new DMUs since no TOC or ROSCO has ordered any new DMU vehicles since 2008, since which time residual value concerns about such trains have increased following the Government's change of policy regarding electrification, and EU emissions legislation has become more demanding.
- The estimated rolling stock savings ignore real cost increases for the capital leasing costs of new electric rolling stock compared with life-extended diesel rolling stock, on the basis that all or most of the BR-procured fleets will have been withdrawn by 2044.
- The estimated savings in Table 8 do not include the potential cost savings from the various rolling stock related initiatives being assessed by the RSSSG for possible implementation in CP5 or CP6 (see paragraph 117).
- The estimated savings do not include potential incremental depot costs (see Section K on page 30).

A Vossloh Type B Class 68 locomotive, being introduced on Chiltern Railways services in 2015

M. Conclusions

The Principle of Franchise-Led Procurement

129. Government policy is that rolling stock procurement should in most cases be franchise-led and the RSS fully supports this principle. The re-shaping of the franchising programme in March 2013 has offered the opportunity to put this approach into action, but in the short term this has been affected by the need to let short contracts to some existing franchisees, and imitations on DfT's operating expenditure budget. This has been countered by the increased emphasis on the value of quality to be delivered within new franchises and TfL concessions.

130. 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 medium term budget constraints should not be made at the expense of whole-life, whole-system value. (For example, the business case for some enhancements such as re-tractioning for some older fleets would become progressively weaker, the longer that they were deferred); and
- the need for short term action should not constrain competitive tension and innovation.

131. RSSSG welcomes the constructive dialogue that has been initiated with the DfT on these issues, and this is continuing. We recognise and understand the DfT's financial pressures and will develop innovative options to improve short term affordability.

132. Articulating the required outputs and allowing the market to decide the optimal means of delivering these would 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

133. The analysis undertaken for the February 2013 and 2014 RSSs has been reviewed and rolled forward. The long term conclusions are largely unchanged, being demand-led. 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 could grow by between 52% and 99% over 30 years, while the proportion of electric (and bi-mode) vehicles could rise from 69% today to more than 90% over the same period.

134. The consequence of the modelled scenarios is that between 13,000 and 19,000 new electric vehicles would be required over the next 30 years, taking account of growth, electrification, replacement by 2044 of most BR-procured vehicles, and HS2. This equates to a build rate of

between 8 and 12 electric vehicles per week and may be compared with an average build rate of just four (diesel and electric) vehicles per week in CP4.

135. This requirement for new electric vehicles is front-loaded. Our updated analysis of fleet sizes in CP5 and CP6 indicates that 1,109 new EMU vehicles are now committed for delivery in CP5 (for England, Wales and Scotland and including TfL's rail concessions), in addition to 2,240 vehicles for the Thameslink, Crossrail and IEP projects. This makes a total of 3,349 new vehicles to be delivered in CP5. Orders have already been placed for 3,019 or 90% of this total of 3,349 vehicles. 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 vehicles delivered in CP4. The CP5 total could yet rise further as new franchises are let. In addition a total of 428 vehicles for the Crossrail and IEP projects, and for the Essex Thameside franchise, have already been committed for delivery in the early years of CP6.

136. Our updated fleet size forecasts show the 'Electric and Bi-mode' fleet totals increasing by between 1,900 and 2,500 over the course of CP6 in the three scenarios. This compares with an increase of between 2,500 and 3,100 over the course of CP5. 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 EMUs which may temporarily be off-lease at the end of 2019 may move back into operational use during CP6. Nevertheless, it appears highly likely on the basis of the assumptions contained in this analysis that the total number of new vehicles required to be delivered in CP6 will be less than in CP5.

137. This analysis illustrates that 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 direct 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, combined with an early commitment to a continuing programme of electrification, should provide a greater degree of predictability about orders for new electric vehicles beyond CP5. This can help manufacturers to optimise production capacity.

138. It is probable that there will be a business case for many of the older BR-procured electric and diesel fleets to receive life extension in CP5 and in CP6.

139. 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 assumed replacement of the 'Pacer' vehicles; and
- the rate of completion of the committed programme of electrification.

140. The number of such additional non-electric vehicles will be relatively small, but this is nevertheless a significant change. RSSSG has undertaken detailed analysis of the total number of Type A and Type B vehicles likely to be required in each year to 2022. This work has indicated a potential requirement for 350 to 500 non-electric vehicles, for a variety of urban stopping, rural stopping and inter-urban express services. This could be resolved by a mix of new construction and/or conversion of older vehicles, including loco-haulage in some instances. In the longer term, up to 1,500 new self-powered vehicles may be required over this 30-year period. This is a small figure compared with the 13,000 to 19,000 new electric vehicles forecast to be required over this period.

141. Timescales are tight but RSSSG is confident that the industry (TOCs, manufacturers and leasing companies) can provide solutions to these issues in CP5 and early in CP6. It is probable that some manufacturers will be willing to develop new non-electric vehicles. Equally, 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.

142. 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

143. Rolling stock-related costs per vehicle mile can be reduced in real terms as a result of these changes because the cost of leasing, maintenance and energy for new electric vehicles are substantially lower than the costs for comparable new diesel vehicles; also the costs of older electric vehicles are significantly less than for comparable older diesel vehicles. 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, based on some initial ranking, illustrate the potential to increase this figure to 62%, 71% or 77% in subsequent years.

144. Future energy costs and the relative costs of diesel fuel and electricity are very difficult to forecast. Electricity costs are currently rising to help pay for lower carbon sources, while diesel fuel costs have fallen sharply. This factor, if it continued in the medium to long term, would have some impact on the business case for some electrification projects, but would not undermine the key conclusions of this RSS.

145. The analysis undertaken by Network Rail for the update of the Electrification RUS will, when finalised, form an input to both the IIP and to the next edition of the RSS.

146. We have adopted the results from a sensitivity test on the 'Low' scenario of the RSS to illustrate what would be the consequences of a slower overall rate of electrification in CP5 through to CP7, pending the development of new assumptions once an electrification programme for CP6 is developed through the LTPP and is approved by government. Any reprogramming of the completion dates of the currently planned electrification projects would have adverse consequences for rolling stock, as follows:
- Slower achievement of the additional capacity required;
- The higher capital cost and whole-life, whole-system costs of any new diesel vehicles (compared with new electric vehicles);
- Incremental costs associated with short initial leases, subsequent transfer to other non-electrified routes, and residual value risks;
- Longer introduction timescales compared with those for new electric vehicles; and
- The lower reliability of diesel vehicles compared with electric vehicles.

147. Investor and supply chain confidence would be enhanced, and costs potentially reduced, if funders could make early commitments to a future electrification programme beyond CP5. Ministerial and departmental commitment to a specific and significant programme of electrification in CP6 would greatly help Network Rail and the suppliers of both electrification

and rolling stock to optimise production capacity and associated costs. This would also give confidence to TOCs and stakeholders that a steady flow of good quality diesel trains will become available to meet growth in demand on non-electrified routes, so reducing the need for expensive new diesel vehicles. It would also help Network Rail to combine synergies of electrification with other major route infrastructure renewals and enhancements.

148. All owners, maintainers, operators and funders of rolling stock and infrastructure should be incentivised to cooperate in working together to adopt a whole-life, whole-system approach to cost reduction and optimisation, as is best practice in other asset based industries. One way in which this could be encouraged would be for the DfT (and Transport Scotland) to insist that rolling stock plans in franchise bids should contain explicit forecasts of whole-life, whole-system costs and benefits, and to give credit in the franchise bid evaluation process for such costs and benefits for the lives of these rolling stock assets (i.e. beyond the end of the franchise being let).

149. At present, no single party is able to calculate or compare the whole-life whole-system rolling stock-related costs (i.e. including maintenance, leasing, energy and track maintenance) of individual rolling stock fleets. As the industry matures one option would be to introduce anonymised benchmarking of whole-life whole-system rolling stock related costs for individual fleets.

150. In each of the three scenarios outlined in this RSS, our work to date indicates that total rolling stock costs per passenger mile could fall in real terms by more than 30% by 2044. 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, for achieving compliance with the PRM-TSI regulations for passengers of reduced mobility, and for the fitting of ETCS. Additional production capacity will be required in order to provide sufficient capacity for all of these programmes.

151. RSSSG is currently reviewing 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, initially during CP5 and CP6.

Depots and Berthing

152. 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 2044, these increases being relative to total capacity at the end of CP5 in 2019. A pan-industry Depot Strategy Steering Group has now been created, to quantify and prioritise longer term requirements, while accepting the principle that provision of additional depot and stabling capacity should be franchise bidder-led wherever possible.

153. Apart from HS2 (for which plans for berthing and for new maintenance depots are already being developed), the largest percentage increases for berthing capacity are forecast to be in the LNW and Western Routes and in Scotland. The growth percentages are driven principally by the forecast high increases in passenger demand for regional services. Percentage increases in berthing required for L&SE TOCs will be smaller, but are likely to be more challenging to achieve so requiring advanced planning.

154. As regards who should provide new and manage new or existing 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.

155. 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.

Customer Benefits and Fleet Reliability

156. This RSS, combined with a continuing programme of electrification, will produce many benefits for customers, 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.

157. 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:
- the MAA of fleet related delay minutes has fallen by around one third while over this same period annual timetabled passenger train miles have increased by 14%;
- the MAA of MTIN has improved by around 100%.

158. Furthermore:
- the 'Modern EMUs' now have an MTIN MAA that is more than twice that of any other category of unit; and
- the 'Old Generation DMUs' and 'Midlife DMUs' have significantly lower MTIN MAA.

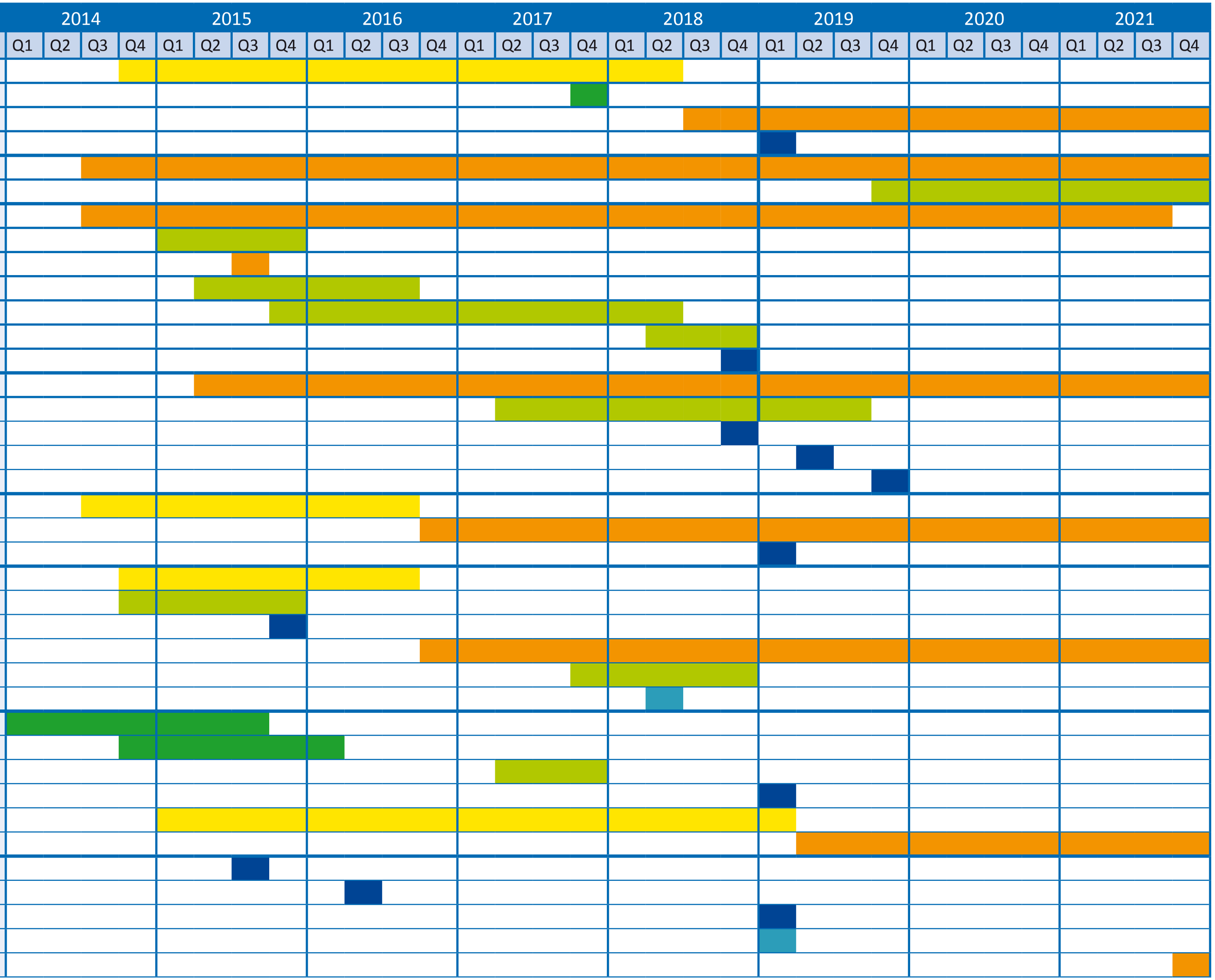
159. The relatively good reliability of the modern EMU fleets is a combination of:
- effective contractual arrangements and incentives;
- the improved extent of system redundancy and other design features; and
- the inherent reliability of the traction systems of a modern EMU.

160. The industry is investigating, and implementing, ways of making more use of standardisation where this can be done without inhibiting the normal commercial process of train procurement and leasing that RSSSG regards is the linchpin to improving overall cost effectiveness in rolling stock provision. Established UK and European industry processes and the market are already leading to increased standardisation in rolling stock. Therefore, there is no pressing need for a new DfT initiative in this area.

A BR-procured Greater Anglia Type F electric trainset dating from the 1970s and 1980s

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

Item	Start	Finish
SE Franchise STAs	10/2014	6/2018
100 Class 377 vehicles sub-leased from GTR to SE		12/2017
IKF New Franchise	6/2018	
Kent Train Lengthening Complete		3/2019
c2c New Franchise	9/2014	
c2c New EMUs (68 cars)	12/2019	12/2021
GTR Franchise	9/2014	9/2021
GTR New Class 387/1 EMUs (116 cars)	1/2015	11/2015
Southern merged with GTR	7/2015	7/2015
GTR New Class 387/2 Gatwick EMUs (108 cars)	5/2015	9/2016
GTR New Class 700 EMUs (1,140 cars)	12/2015	6/2018
GTR New Moorgate EMUs (150 cars)	5/2018	11/2018
Thameslink Key Output 2 incl ERTMS		12/2018
Crossrail Concession	5/2015	
Crossrail, New Class 345 EMUs (594 cars)	5/2017	7/2019
Crossrail Core and Abbey Wood Services		12/2018
Crossrail to Shenfield		5/2019
Crossrail to Reading		12/2019
GA Franchise STA	7/2014	10/2016
GA new Franchise	10/2016	
GE and West Anglia Capacity Enhancements		1/2019*
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 (170 cars)	12/2017	12/2018
Gospel Oak - Barking Electrification		6/2017*
SWT Class 458/5 conversion (180 cars)	3/2014	9/2015
SWT Class 455 re-powering (364 cars)	11/2014	1/2016
SWT New Class 707 EMUs (150 cars)	6/2017	12/2017
SWT Full 10-car Operation (Inners & Reading)		3/2019*
SWT Franchise STA	1/2015	3/2019
SWT New Franchise	4/2019	
Chiltern Train Lengthening		8/2015
Chiltern Services to Oxford		6/2016
East West Rail, Oxford - Bletchley/ Bedford		3/2019*
East West Rail Electrification, Oxford to Bletchley		3/2019*
Chiltern New Franchise	12/2021	

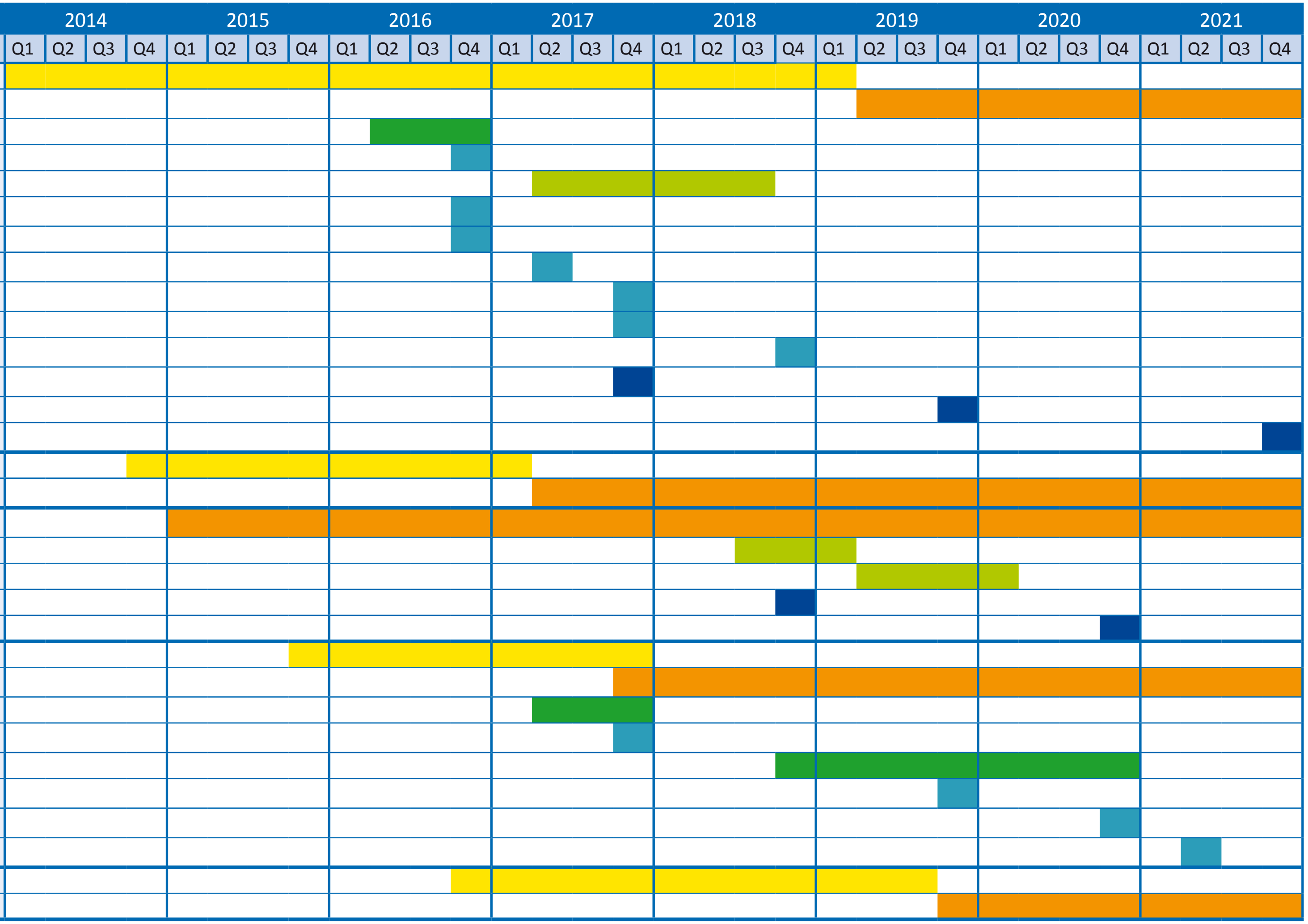


Franchise STAs | New Franchises | Electrification Complete | Other Infrastructure Complete | Committed New Rolling Stock | Other Rolling Stock

Network Rail dates are as in the CP5 Enhancements Delivery Plan (December 2014), with ERTMS dates as in the rebased ETCS Deployment Plan (August 2014).
****Indicative dates***

APPENDIX 2, TIMELINE OF KEY ACTIVITIES RELATING TO INTERCITY FRANCHISES

Item	Start	Finish
FGW Franchise STAs (end date to be confirmed)	10/2013	3/2019
GW New Franchise (start date to be confirmed)	4/2019	
Rolling Stock for Thames Valley Electrification	3/2016	12/2016
GWML Electrification, Oxford and Newbury		12/2016
GW New Class 800/801 IEP trains (369 cars)	5/2017	7/2018
GWML Electrification, Oxford and Newbury		12/2016*
GWML Electrification, Chippenham and Bristol Parkway		12/2016*
GWML Electrification, Chippenham to Temple Meads		5/2017*
GWML Electrification, Temple Meads to Cardiff		12/2017*
GWML Electrification, Thames Branches		12/2017*
GWML Electrification, Swansea and Full Timetable		12/2018*
GWML ERTMS Paddington to Didcot		12/2017
GWML ERTMS to Newbury, Oxford, Bristol, Taunton		12/2019
Western Rail Access to Heathrow		12/2021*
VT Franchise STA	11/2014	4/2017
ICWC New Franchise	4/2017	
ICEC New Franchise	3/2015	
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
ICEC ERTMS, KX and Moorgate to Wood Green		12/2018
ICEC ERTMS, Wood Green to South Doncaster		12/2020
EMT Franchise STA	10/2015	10/2017
EM New Franchise	10/2017	
Rolling Stock for MML Phase 1 Electrification	4/2017	12/2017
MML Electrification, Kettering and Corby		12/2017
Rolling Stock for MML Phases 2&3 Electrification	12/2018	12/2020
MML Electrification, Derby and Nottingham		12/2019
MML Electrification, Sheffield		12/2020
Electrification, Sheffield to the ECML		6/2021*
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 CP5 Enhancements Delivery Plan (December 2014), with ERTMS dates as in the rebased ETCS Deployment Plan (August 2014).
****Indicative dates***

APPENDIX 3, TIMELINE OF KEY ACTIVITIES RELATING TO REGIONAL FRANCHISES

Item	Start	Finish
Northern Franchise STA	4/2014	2/2016
FTPE Franchise STA	4/2015	2/2016
Northern New Franchise	2/2016	
TPE New Franchise	2/2016	
FTPE New Class 350 EMUs (40 cars)	12/2013	4/2015
EMUs for NW and NE Electrification Schemes	5/2014	12/2018
NW Electrification, Liverpool to WCML		3/2015
NW Electrification, Preston to Blackpool		2/2017
NW Electrification, Manchester to Preston		12/2016
Windermere Electrification		12/2016
NTPE Electrification, Leeds and York/Selby		12/2018*
EMUs for NTPE Electrification	1/2018	12/2018
Northern Hub Programme, Full Timetable		12/2018
ERTMS Cumbrian Coast North		12/2019
ERTMS Carlisle - Newcastle		12/2020
ScotRail New Franchise	4/2015	
Caledonian Sleeper Franchise	4/2015	
ScotRail Electrification, Cumbernauld/Whifflet		12/2014
Borders Railway Reopening		6/2015
Caledonian Sleeper, New Rolling Stock (74 cars)	6/2018	6/2019
Edinburgh-Glasgow Electrification, Initial Service		12/2016
Edinburgh-Glasgow Electrification, 8x23m trains		3/2019
ScotRail Electrification, Alloa, Dunblane, Shotts		3/2019
ScotRail, New EMUs (EGIP etc, 234 cars)	12/2017	12/2019
LMR New Class 350 EMUs (40 cars)	10/2014	11/2014
LMR Franchise STA	4/2016	6/2017
WM New Franchise	6/2017	
Barnt Green - Bromsgrove Electrification		7/2016
Walsall - Rugeley Electrification		12/2017*
W&B New Franchise	10/2018	
EMUs for Valleys Electrification	12/2018	12/2019
South Wales Valleys Electrification		12/2019*

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

Network Rail dates are as in the CP5 Enhancements Delivery Plan (December 2014), with ERTMS dates as in the rebased ETCS Deployment Plan (August 2014).
**Indicative dates*

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	320	800	
143	168	222	345	321	801	
144	170	HST	376	322		
150	171		378	323		
153	172		455	332		
155	175		456	333		
156	185		465	334		
165			466	350		
			507	357		
			508	360		
			707	365		
				375		
				377		
				379		
				380		
				387		
				442		
				444		
				450		
				458		
				700		
				AT200		

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 15, 16, 45 and 49 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	74		Ordered
c2c, Type E	0	68	
Gatwick Express Class 387/2	108		Ordered
LOROL, Class 378	57		Delivery commenced (3)
LMR Class 350	40		Delivered
Moorgate Type D	150		
ScotRail AT200 Type E	234		Ordered (4)
SWT Class 707	150		Ordered
TfL, Type D	180		(5)
Thameslink Class 387/1	116		Delivery commenced (6)
Subtotal, Other	**1,109**	**68**	
TOTALS	**3,349**	**428**	

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) Extends all Class 378 units from 4-car to 5-car length.
(4) Financial close not yet achieved. 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.

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

GLOSSARY

AC	Alternating Current
ATOC	Association of Train Operating Companies
BIS	Department of Business, Innovation and Skills
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
c2c	The TOC which operates the Essex Thameside franchise
DC	Direct Current
DfT	Department for Transport
DMU	Diesel Multiple Unit
DPI	Delay per Incident
EC	European Commission
ECAM	Enhancements Cost Adjustments Mechanism
ECML	The East Coast Main Line
EGIP	The Edinburgh – Glasgow Improvement Project
Electric Spine	The route to be electrified between Southampton, Bedford and the West Midlands
EMT	The East Midlands Trains TOC
EMU	Electric Multiple Unit
ERTMS	European Rail Traffic Management System
ETCS	European Train Control System
FGW	The First Great Western TOC
FTPE	The First TransPennine Express TOC
FutureRailway	A collaboration of Network Rail and RSSB, to accelerate research and innovation

GA	The Greater Anglia TOC
GE	Great Eastern
GTR	Go-Ahead Thameslink Railway
GW	Great Western
GWML	Great Western Main Line
HLOS	High Level Output Specification
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
IKF	The Integrated Kent Franchise
IPEMU	Independently Powered EMU
ISBP	Industry Strategic Business Plan
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
NRMM	Non-Road Mobile Machinery emissions legislation (see paragraph 48)
NSARE	The National Skills Academy for Railway Engineering
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
ORR	Office of Rail Regulation
PRM-TSI	Technical Specification for Interoperability, for Passengers of Reduced Mobility
RDG	Rail Delivery Group
RIA	Railway Industry Association
ROSCO	A company that owns and leases rolling stock
RSG	The Rail Supply Group
RSS	The Long Term Passenger Rolling Stock Strategy
RSSSG	Rolling Stock Strategy Steering Group (see paragraph 1)

RUS	Route Utilisation Strategy
SE	South East
SoFA	Statement of Funds Available
STA	Single Tender Action i.e. a short franchise awarded to an incumbent TOC
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
VT	The Virgin West Coast Franchise
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 franchise

A Bombardier London Overground Type D Class 378 'Electrostar' EMU of 2008, now lengthened to 5-car formation in 2015