High Speed Rail
London to the West Midlands and Beyond

A Report to Government
by High Speed Two Limited

Further copies of this report can be obtained from www.hs2.org.uk.

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Unless specified, all maps, tables, diagrams and graphs in this report are a product of HS2 and its consultants.

Chapter 1:
ICE 3 high speed train on the Frankfurt-Cologne high-speed rail line, Sebastian Terfloth;
Eurostar, Dave Bushell www.canbush.com/ppbfrontpage.htm;
Gümmenen viaduct over the river Sarine with TGV 9288, Berne, Switzerland, Chriusha;
Tunnelling, HS1 Ltd
AVE Tarragona-Madrid, Fototrenes
St. Pancras Station, HS1 Ltd

Chapter 5:
Matisa www.matisa.com/matisa_ang/matisa_produits.html

Foreword

Britain built only one new transport network in the twentieth century, the motorway system. Its origins lie in a report prepared for the war time Cabinet and one which attracted all party agreement. The first map of a projected motorway system, in which we can recognise today's reality, was published in 1946. It was more than a decade later before the first stretch of motorway opened.

The only new network we can expect to build in the twenty first century is for high speed rail. It will be an endeavour just as challenging in terms of cost and timescale as building the motorways. This report sets out the case for building a high speed rail network, how it might be constructed and a vision of how it should look. We envisage a network of high speed lines and services, bringing together the main conurbations of England and Scotland but integrated with the classic railway so that the benefits can be spread more widely. As a first step, we set out in the report a detailed and buildable route from London to the West Midlands.

Building such a network will be the work of a generation. It will need real ambition and consistency of purpose across a succession of Governments. It will require support across the political divide of a kind our forebears showed more than half a century ago.

It will be an enormous challenge simply to build a high speed network. The second challenge will be to make it a success. The new network will only be a twenty first century success if it breaks with twentieth century railway thinking and practices. It makes no sense to spend billions only to recreate today's railway.

A great many have helped us to prepare this report and we owe them all our thanks. If Britain is to build a high speed network then much more will be needed by way of assistance. In the end, a truly national network can only be built by national endeavour.

Sir David Rowlands

Chairman

High Speed Two Limited

December 2009

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Executive Summary

The Context for HS2

High Speed Two Ltd (HS2 Ltd) was established in January 2009 to develop proposals for a new high speed railway line between London and the West Midlands and to consider the case for high speed rail services linking London, northern England and Scotland.

This report presents our advice to Government. It offers a thorough assessment of the case for building Britain's next high speed line to the West Midlands and a viable proposal for its construction, with options for the Government to consider.

It also sets those plans within a long term vision and context for high speed rail in the UK. Our work points to a good case for developing a network of high speed lines with branches from the West Midlands to the east of the Pennines, serving cities in the East Midlands, Yorkshire and the North East, and west of the Pennines, serving the North West and Scotland.

Our Approach

There are various models of high speed rail in operation around the world. We have sought to tailor an approach that fits with the particular circumstances in Britain and which is sufficiently flexible to allow for the growth and evolution of a wider network.

We recommend that six principles form the basic model for high speed rail in the UK:

1. High speed capacity should be used in a way which yields the maximum overall benefit, given its high cost and expected strong demand.
2. High speed rail services should serve long distance, city-to-city journeys rather than shorter distance trips.
3. New high speed lines should only be used by high speed trains. Adding slower trains reduces capacity.
4. In the early stages of developing a network, the benefits should be extended to cities further north with trains running off the high speed line and onto the existing classic network. This is crucial to the business case.
5. Over time, however, the longer term high speed network should become more segregated from the constrained classic network to maximise the benefits of reliability and capacity.
6. High speed lines must be well integrated with other transport networks to allow the time savings to be carried through to the whole end-to-end journey.

We have sought to ensure a robust approach through independent expert challenge and close collaboration with relevant organisations. We have drawn on major project experience accumulated in the UK and overseas experience of high speed rail. We have also sought to maximise the value of our wider stakeholders' input by adopting as open and inclusive an approach as possible. During the course of the year we met over 200 different interested parties.

Our specific proposals for HS2 have been focussed on serving the places where people live, work and visit. To guide the design we developed a project specification, comprising the line's main technical, operational and environmental requirements.

Key features are:

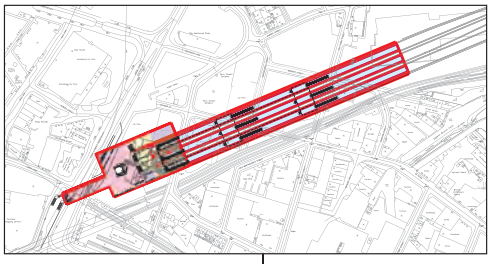
- The infrastructure is designed for speeds up to 400kph (250mph) – a higher maximum speed than existing lines but in line with designs for future routes in Europe.
- The adoption of proven European standards, technology and practice.
- Capacity for 400m-long European-sized trains, which are higher and wider than UK rolling stock and with up to 1100 seats.
- An initial capacity of up to 14 trains per hour for HS2, rising ultimately to 18 with a longer term network and likely future technological development.
- At opening, we assume a maximum train speed of 360 kph (225mph).
- The design should follow the Government's sustainable development objectives, avoiding as far as possible harm to the natural and built environment and to communities.

Underlying our approach was also the requirement to achieve value for money, by striking an appropriate balance between costs and the design aims.

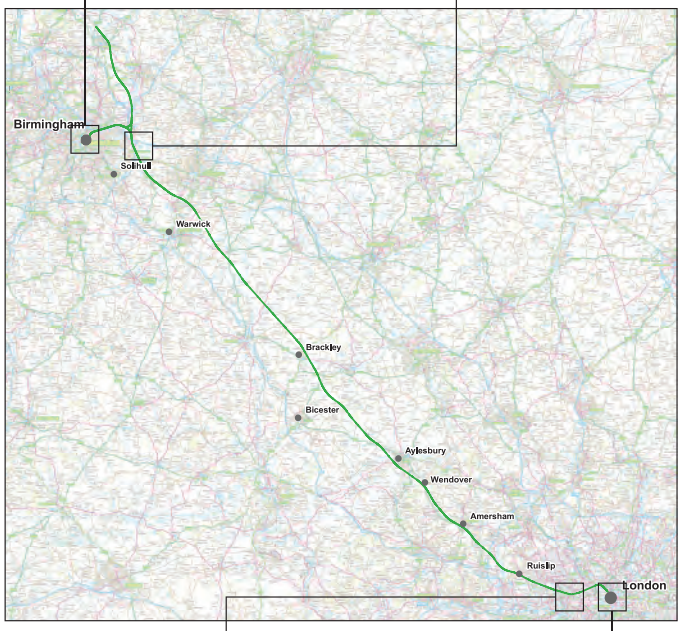
The Preferred Scheme

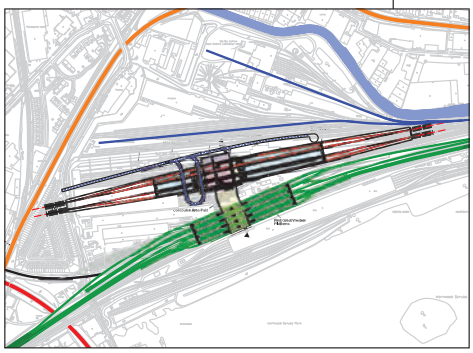
An extensive and systematic process of option sifting and assessment has led us to identify our recommended route between London and the West Midlands and two possible alternatives. The report describes this process and its results and the supporting documents describe the components in depth.

A central Birmingham terminal station near Fazeley Street, in the Eastside area of the city.



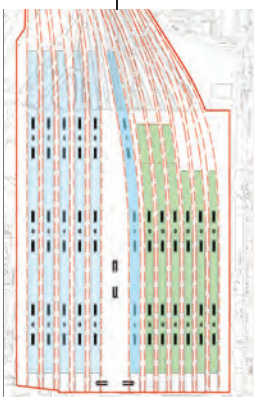
A Birmingham Interchange station on the line of the route near Birmingham International Airport.





An interchange station with Crossrail, Great Western Main Line and Heathrow Express connections, at Old Oak Common, near Willesden.

A central London terminal station at Euston, expanded to accommodate high speed services.



The recommended route leaves London via the Ruislip district, crosses the Chilterns in the Aylesbury direction, partly in tunnel, and approaches Birmingham on an alignment between Coventry and Kenilworth. In the report we also present two alternatives to the main line of route, one following a more westerly route through the Chilterns via Gerrards Cross, and the other following the West Coast Main Line corridor further to the east.

In the West Midlands, the line skirts to the east of Birmingham, with a short spur into the city centre from the Water Orton area. An alternative alignment to the east of the city is also presented, alongwith a second route into Birmingham along the Coventry corridor.

The routes, with alternatives, have been developed in detail, with alignments plotted to a corridor width of +/- 25 metres.

We concluded that city centre stations should be an essential part of the scheme. For London, we recommend a single level, completely rebuilt and expanded station at Euston, serving high speed services alongside classic services. In Birmingham, we recommend a new station in the Eastside area near Fazeley Street, developed in an integrated way with the existing Moor Street and New Street stations.

Our remit required us to include a station serving Heathrow and an interchange with Crossrail and the Great Western Main Line. In the first stage of the development of a high speed network, we recommend an interchange station at Old Oak Common, in the west of London near Willesden. This could significantly relieve passenger dispersal pressures at Euston, by offering access to the West End, the City and Canary Wharf via Crossrail; and it could provide easy interchange to fast services into Heathrow Airport.

We also recommend an interchange station in the West Midlands, extending the overall West Midlands market and providing very fast connections between London and the outskirts of Birmingham, Birmingham International Airport and the National Exhibition Centre.

HS2 would offer regular journey times between the centres of London and Birmingham of 49 minutes – a saving of more than 30 minutes on today's standard service.

A connection to the West Coast Main Line would allow high speed trains to run off HS2 and on to major destinations further north. Typically these destinations, including Manchester, Liverpool, Preston and Glasgow, would benefit from around 30 minute savings on journey times to London.

London - Birmingham	Arr	Dep
Euston	—	10:00
Old Oak Common		10:07
Birmingham Interchange	10:38	
Birmingham Fazeley Street	10:49	—

Passengers would be able to connect with National Rail services at each station, with Crossrail at Old Oak Common and via a rapid transit people mover with the NEC and Airport at Birmingham Interchange station.

We have concluded that further intermediate stations on the line of route between London and the West Midlands would not offer value for money.

In the report we present options for serving Heathrow Airport directly via a loop from our proposed route, possibly as the network is extended in the longer term. We also present options for building a connection to High Speed One (HS1) for through services to mainland Europe. In neither instance is there a clear cut economic case for doing so at this stage, given the costs involved. Providing a loop to Heathrow would add at least £2.5bn, after risk is included, to the overall cost. An HS1 connection would add more than £1bn. While passive provision could be made for a Heathrow loop, we recommend that, should Government wish to pursue the HS1 connection, at least the tunnel should be built for Day One to avoid costly disruption at a later date. We also highlight the option of providing passenger connections to HS1 at St Pancras International by way of an advanced people mover from Euston.

The Business Case

Demand

HS2 would transform the long distance rail market. By 2033, each day some 145,000 HS2 passengers would be transported into and out of London, with about 54,000 passing through the two Birmingham stations.

Without HS2, the West Coast Main Line would become severely capacity constrained, with the likelihood of passengers being crowded off trains during the peak hours.

At a national level, over half of the passengers on HS2 services would otherwise have travelled by classic rail. A further 16% would come from mode shift, split equally between air and car trips. The remaining 27% would be new trips, with more people travelling more often due to the faster journeys offered by high speed rail.

Of the daily journeys 30% are made by business passengers and the balance by mainly leisure passengers.

Costs

HS2 can be built only at very substantial cost. Our estimates have been built up from the engineering plan and profile drawings of our preferred route and alternatives. We have subjected our cost modelling to extensive peer review and carried out a significant benchmarking analysis with European high speed lines and with HS1 as comparators.

The construction of HS2 would generate capital costs of between £15.8 and £17.4 billion, including risk and optimism bias, but excluding rolling stock. We have given costs as a range in order to reflect the level of uncertainty inherent in a project at this stage.

The costs forecast for HS2 are broadly comparable to the costs of HS1, but remain significantly more than those of other European high speed rail projects. Our analysis has pointed to certain differences which partly explain this. For example, European projects have normally avoided major station developments and new urban routes through exploiting under-used existing rail capacity and have generally incurred lower land costs. Nevertheless, a major challenge in taking forward construction of high speed lines in the UK would be how to achieve greater parity with European construction costs.

Appraisal

We forecast that the preferred HS2 scheme would generate transport user benefits worth £29bn (2009 PV), as well as additional revenues worth £15bn (2009 PV). This is driven almost entirely by time savings – which also reflect benefits from relief of crowding. Wider Economic Impacts would add a further £4bn or additional 11%.

HS2 would bring benefits not only for direct users. Capacity freed up on the West Coast Main Line would allow users of shorter distance services to gain through faster, more frequent and less crowded services. Overall this is expected to deliver benefits of around £2-4bn. There would also be capacity for freight growth on the southern section of the WCML, the principal UK railfreight corridor.

Balanced against the costs of construction and operation, we calculate that HS2 would demonstrate a Benefit Cost Ratio (BCR) of 2.7 : 1 including Wider Economic Impacts. Consistent with the range of costs, the range of the BCR would be 2.5 - 2.9. Without Wider Economic Impacts the central figure would be 2.4 : 1.

HS2 would have both positive and negative effects on transport emissions. The ultimate impact depends critically on a number of external factors (such as the grid intensity of electricity) which we set out in the report. Taking these variables into account, we calculate that the impact of HS2 on carbon emissions will be between a reduction in emissions of 25 million tonnes of CO2 and an increase of 26.6 million tonnes of CO2 over 60 years. This is small when set in the context of overall transport emissions.

We have sought to design HS2 to minimise its effect on people and the natural environment. However, a construction project of this magnitude cannot completely avoid environmental impacts, particularly in relation to noise and landscape. In particular the line would affect a corridor within the valued landscape of the Chilterns. Nor can it avoid land take and property impacts, particularly around the station sites in London and Birmingham. After including these impacts, we believe that the scheme remains high value for money (i.e. it delivers at least £2 of benefits per £1 of Government spending).

There are significant opportunities for development and regeneration in the areas immediately around the new stations in London and Birmingham, including at the Old Oak Common interchange. Ensuring a high degree of integration between the design of HS2 stations and the relevant local transport and development plans will be critical.

Implementation

Construction of HS2 could begin by 2018. Before then the project would need to pass through three investment approvals; provisional approval for the preferred route; conditional approval after securing the necessary powers and final approval before start of construction.

Effective public consultation will be critical. We recommend two consultation stages: the first on the Government's proposed strategy in relation to this report and the second to follow after further detailed design of the preferred route. This would be associated with the process of securing powers, on which we present options.

We provide advice on a range of options for project delivery, drawing a number of key conclusions on the future delivery of UK high speed rail projects:

- Government must make an early decision on whether HS2 is intended to be a stand-alone high speed rail line project or the first phase of a future high speed rail network as this influences the delivery structure and financing opportunities.
- Long term stability is essential for a project of this size and duration; we recommend this is achieved through an arm's-length public sector body as project sponsor.
- Public sector procurement will offer best value for money for the majority of the construction.
- There should be a single owner and operator of high speed line infrastructure.

We have also explored various funding sources and mechanisms. HS2 cannot be built without substantial up-front public sector investment, though once constructed HS2's revenues would more than cover the cost of its operation. We believe the scope for additional funding sources is unlikely to exceed 5% of the total project cost. Major capital spending would not be required until 2017/18, and would be spread over a period of 6-10 years. The Government would then have the flexibility to decide how HS2's operations were to be delivered over the long term, including exercising a "build for sale" option, which might also offer the prospect of a financial contribution to the next phases of a high speed rail network.

HS2 would be one of the largest construction projects undertaken in the UK, with the potential to create up to 10,000 construction jobs, and a further 2,000 permanent jobs through maintenance and operation.

On our provisional timetable, HS2 could open in late 2025.

Developing a Longer Term Strategy

We have studied the prospects for developing HS2 into a network of high speed lines to the north. This analysis has been undertaken at a corridor level; we have not developed route proposals.

We show that there is a case for a network with branches to the east and west of the Pennines, taking high speed rail to the North West and Scotland, to the East Midlands, Yorkshire and the North East.

Our proposals for the London to West Midlands line have been designed to be consistent with this longer term network. We have also considered whether, with this network, there is a case for passive provision for four tracks between London and the West Midlands. We concluded that two tracks would be sufficient for the foreseeable future and that, should greater demand materialise eventually, it would be preferable to provide a second, separate line from the East Midlands to London.

Our proposed longer term network would bring radical journey time savings. Manchester and Leeds could be accessed from London in around 1hr 20 minutes. Both the East Midlands and West Midlands would be less than an hour from London. Edinburgh and Glasgow would be 2hrs 40 minutes from London, making high speed rail highly competitive with aviation.

The overall network demonstrates a good BCR. We have also examined Manchester and Leeds as the possible next stages and both show a good business case. Further work would be required to investigate routes in more detail and to analyse the impacts in greater depth. However, we believe our findings can give Government confidence that there is a substantial case for deploying further resources on such work and we recommend both the North West and Yorkshire via the East Midlands as priorities for the next stage.

Chapter 1 – The Context for HS2

1.1 Rationale and specific remit

Rationale and high speed objectives

1.1.1 In January 2009 the Government announced a package of decisions on the long term future of Britain's transport infrastructure. Alongside confirming policy support for a third runway at Heathrow and confirmation of a £6bn strategic road investment programme, High Speed Two Limited (HS2 Ltd) was created as a Government company to examine the case, and develop proposals, for a new high speed railway line between London and the West Midlands – 'HS2' – and potentially beyond.

1.1.2 We were asked to focus our attention on a corridor between London and the West Midlands, principally because the evidence at the time showed that, of all the UK main lines, the West Coast would be first to experience a shortfall in capacity, which would begin to affect the line south of Birmingham in about 15 years. Constraints on capacity bite in three ways – firstly the line cannot carry more trains; secondly the trains cannot be made longer; and thirdly as all spare capacity on the route is used up the overall route performance becomes less resilient. This means that the frequency of the service can never be improved or extra room made for freight, and the trains that do run become crowded, uncomfortable and unreliable.

1.1.3 The West Coast Main Line (WCML) is a critical north-south artery for both passenger and freight, connecting the largest cities in England and Scotland. At the southern end of the route it is also a vital commuter line serving growth towns such as Northampton and Milton Keynes. From the outset we have taken the need to provide additional passenger capacity on the London to West Midlands route as a key rationale for constructing a new line between these locations.

What is 'high speed' rail?

Although 'High Speed Trains' have been running on the principal UK network since 1975, their top speed of 200kph (125mph) now pales in comparison with the fastest trains in use, on High Speed One (HS1) and elsewhere in the world, which can regularly reach speeds of 300-350kph (186-217mph).

These trains operate either on new fully segregated networks – such as the UK's HS1 and the Linea de Alta Velocidad in Spain; or run on a mixture of newly built lines and existing track – as do the TGV in France and the ICE services in Germany.

In order fully to exploit their speed capability, high speed trains need to run non-stop over long distances and so high speed networks tend to be characterised by major city-to-city routes, engineered to be as straight as possible to optimise journey times.

The speed of these journeys can be transformative. People in Madrid can now reach Barcelona by rail in 2hrs 38mins – compared with 6hrs before. Paris and Marseille are now around 3hrs apart – having once been 5hrs.

In this report we deal with both mixed and segregated running and take 360kph (223mph) as our benchmark aspirational speed.

1.1.4 But there would be other objectives for any new line, particularly when set in the context of the existing transport network. From the outset a new line to the West Midlands could offer journey time savings not just between London and Birmingham, but to other major cities further north, such as Manchester, Liverpool and Glasgow – which would benefit from having services run at higher speeds for a portion of the journey. Wherever journey times can be shortened there are real gains to be won: for business people who can spend longer on productive activities and forge better links with their clients and colleagues; for commuters who can make more efficient use of their time and access employment further afield; and for leisure passengers who can make journeys more easily to distant friends and relatives. These gains translate to society as a whole – by extending productivity and expanding labour markets. We viewed the unlocking of those benefits as another key objective of any new line.

1.1.5 In the same way, it is clear that a new line has the potential to improve connectivity, opening up new journey possibilities for passengers. A new north-south line could be linked to Heathrow, either directly or via an interchange with Heathrow Express and Crossrail, and could connect with the international network via a link into High Speed One (HS1).

1.1.6 A new high speed line should not be seen in isolation as merely a transport project. Where faster, easier journeys are possible, high speed rail can support economic regeneration and growth. Just as housing and employment growth often results in the need for enhanced transport links, so too can the provision of such transport links act as a catalyst for development. We recognised that a further objective of a new line between London and the West Midlands should be its integration with potential land use changes, both directly in the areas it affects and indirectly in the areas which would benefit from the capacity that is freed up on the WCML.

1.1.7 Lastly, a new line may offer the possibility of attracting passengers off congested roads and domestic flights onto rail. These modal shift objectives are legitimate aims for high speed rail, although we must be realistic about the scale of their potential contribution to the Government's overall carbon reduction strategies. Any carbon savings need to be balanced against carbon costs both embedded within construction and those generated by the net additional trips which high speed rail enables. These issues are considered more fully in Chapter 4.

Providing new passenger capacity	Creating faster journeys	Encouraging modal shift	Improving connectivity	Supporting regeneration and growth

1.1.8 Together these objectives have been the motivation behind many of the high speed rail projects around the world. The core rationale for considering the construction of a high speed line between London and the West Midlands at this time is the need to meet the anticipated shortfall in capacity. This is a problem, visible on the near horizon, and it requires a solution. The Government will properly wish to consider various ways of solving that problem, but our task has been to examine the case for a new line to provide the answer. In the end though, that case may well be made in part by the additional benefits that high speed rail can achieve, rather than by providing capacity alone. And as we contemplate a more extensive network stretching northwards, the benefits of shorter journeys, greater connectivity and modal shift from air are increasingly likely to take precedence over capacity.

1.1.9 Without doubt, achieving any of these objectives would come at considerable cost. The capital cost of the infrastructure would run, unavoidably, into billions of pounds and while new railway lines can have very positive impacts at their stations and on the areas they serve, their negative impacts – in land take, noise, visual intrusion – can be acutely felt by many. The appraisal that follows in Chapter 4 assesses the overall balance between these benefits and costs.

HS2 Ltd's remit and scope

1.1.10 Mindful of the objectives described above, we were tasked with the following remit in respect of London to the West Midlands:

To consider and to provide advice to the Government on the costs and benefits of:[1]

a. *A proposed route with any options as appropriate;*

b. *Options for a Heathrow International interchange station on the Great Western Main Line with an interchange also with Crossrail;*

c. *Options for access to central London and the other cities served;*

d. *Options for linking with HS1 and the existing rail network, including the potential for services to continental Europe;*

e. *Options for providing an intermediate parkway station between London and the West Midlands. Any such station should not be detrimental to the overall business case, and should support economic and spatial strategies;*[2]

f. *Financing and construction proposals.*

1.1.11 In addition, we were asked:

..to provide advice on the potential development of a high speed line beyond the West Midlands, at the level of broad 'corridors'...[and] to consider in particular the potential for HS2 to extend to the conurbations of Greater Manchester, West Yorkshire, the North East and Scotland.[3]

1 Britain's Transport Infrastructure: High Speed Two. Published by DfT 15 January 2009
2 Confirmed in the remit letter from Lord Adonis to Sir David Rowlands. Available at www.hs2.org.uk
3 Confirmed in the remit letter from Lord Adonis to Sir David Rowlands. Available at www.hs2.org.uk

1.1.12 Accordingly, our work has been pitched at two distinct levels. For HS2 – between London and the West Midlands – we have carried out work at a sophisticated level of detail and analysis, in order that Government is presented with sufficiently comprehensive evidence and advice to allow a soundly based public consultation on specific route proposals and appraisal results in 2010 – as is the stated intention. To that end we undertook to produce the following:

- A proposed route option and possible alternatives.
- Appropriate economic, environmental and social assessments to support a public consultation, with a business case that addresses value for money, affordability and deliverability.
- A proposed technical specification of the new line.
- A proposed location for train maintenance facilities and stabling.
- A proposed location for infrastructure maintenance facilities.
- An identification of the capacity released on the classic line.
- Options for structuring the project for delivery and financing.
- An assessment of the implications for public funding.
- A recommended public consultation strategy.
- A recommended approach to obtaining powers.
- A blight management and safeguarding strategy.
- An outline plan and timetable through to opening.

1.1.13 The latter part of our remit, looking nationally at the possible corridors for a future network – what we have termed the 'longer term strategy' – has been deliberately undertaken at a more conceptual level. The purpose, at this stage, has not been to identify fully engineered routes, costed to a detailed level, nor to develop the business case beyond a preliminary stage. Rather, the purpose and scope of our work on the longer term strategy has been to set out a possible vision and context for the core HS2 route, in order to inform its design and ensure it remains 'future-proofed'; but also to learn the lessons and generate the evidence that will allow Government to focus its planning and resources on where high speed rail can yield the greatest benefit. This element of our work seeks to complement, and build on, work being carried out by others, most notably Greengauge 21 and Network Rail, in laying the groundwork for the possible extension of a high speed network.

1.1.14 This report, together with the documents that support it, aims to fulfil the requirements of both aspects of our work.

The status of HS2 Ltd

1.1.15 As a Government-owned company tasked with developing plans for a major railway infrastructure project HS2 Ltd follows two notable predecessors: Union Railways Ltd, which was established by British Rail in the early nineties to bring forward plans for the Channel Tunnel Rail Link; and Cross London Rail Links Ltd, a joint venture between the Strategic Rail Authority (SRA) and Transport for London (TfL), which was set up in 2002 to develop proposals for Crossrail. Following a similar model, HS2 Ltd was created as a separate company, at arm's length from Government, and staffed in part by secondees from the Department for Transport (DfT) and Network Rail, along with others from elsewhere in the public and private sectors.

1.1.16 From the outset there have been two aspects to our role – both to carry out an objective consideration of the case for HS2, but also to recommend proposals which stand up to scrutiny and reflect the aspirations and concerns of those potentially affected. Throughout this process we have sought to conduct an objective and professional investigation, grounded in a solid evidence base and informed by the varied views of others.

1.1.17 Throughout the year we have worked closely with a number of organisations whose specialist and local knowledge has helped to inform our investigation. Indeed their views and advice have been reflected in many of our conclusions. However, our findings, which we now present to Government, are ours alone and the support of the organisations we have consulted should not be automatically assumed.

1.1.18 We have also commissioned specialist consultancy advice on a range of topics. The firms that have advised us are listed below and their reports make up several of the supporting documents published alongside the report. Again, HS2 Ltd takes full responsibility for the findings and recommendations we present.

Arup Group Ltd	Engineering services
WS Atkins plc **Sinclair Knight Merz Pty Ltd** **Arup Group Ltd**	Demand Modelling and Appraisal - (subcontracted by WS Atkins)
Booz & Company Inc **Temple Group Ltd**	Sustainability and Appraisal
BSL Management Consultants	European Cost Benchmarking Analysis
CB Richard Ellis Ltd	Land and Property
Dr Dan Graham & Patricia Melo	Advice on the assessment of Wider Economic Impacts
Ernst & Young LLP	Financial advisory services
Eversheds LLP	Legal advisory services
Oliver Wyman Group	Commercial advice
Reg Harman	Advice on the spatial impacts of high speed rail

1.2 The domestic and international context for HS2

Introduction

1.2.1 High speed rail – though employing the most modern technology to deliver very different journeys from today – must be considered and assessed as part of the wider transport network in which it would operate. It would rely on the existing infrastructure to sustain its demand and extend its benefits; it would change the journeys people make and how they make them; and where it relieves capacity in places, it may put strain elsewhere. At the same time plans for HS2 must recognise and respond to the Government's policy priorities, which in turn must interact with the changing nature of the economy, the environment, the way people live, and where people live. Moreover as well as being able to adapt to the future, we must learn lessons from the past, and pay heed to the wealth of experience amassed from high speed rail projects both at home and abroad. Therefore it is important that we set HS2 in its domestic and international context.

1.2.2 In building a reference case for HS2 – essentially a description of the future against which we will assess the case for building a new line – we detail various assumptions which we have made about the future, and other sensitivity tests that will allow us to vary that model and gauge the impact of certain changes. Generally speaking the assumptions follow from stated Government policy and forecasts, and these are discussed in more detail in Chapter 2. The purpose of this chapter though, before broaching that detail, is to map the broad policy landscape and consider its interplay with HS2.

HS2's place in the UK transport network

1.2.3 Over the last thirty years, road and air passenger transport have both grown steadily, and in the last fifteen years rail travel has also seen an unprecedented surge in passenger kilometres, as Figure 1.2a demonstrates.

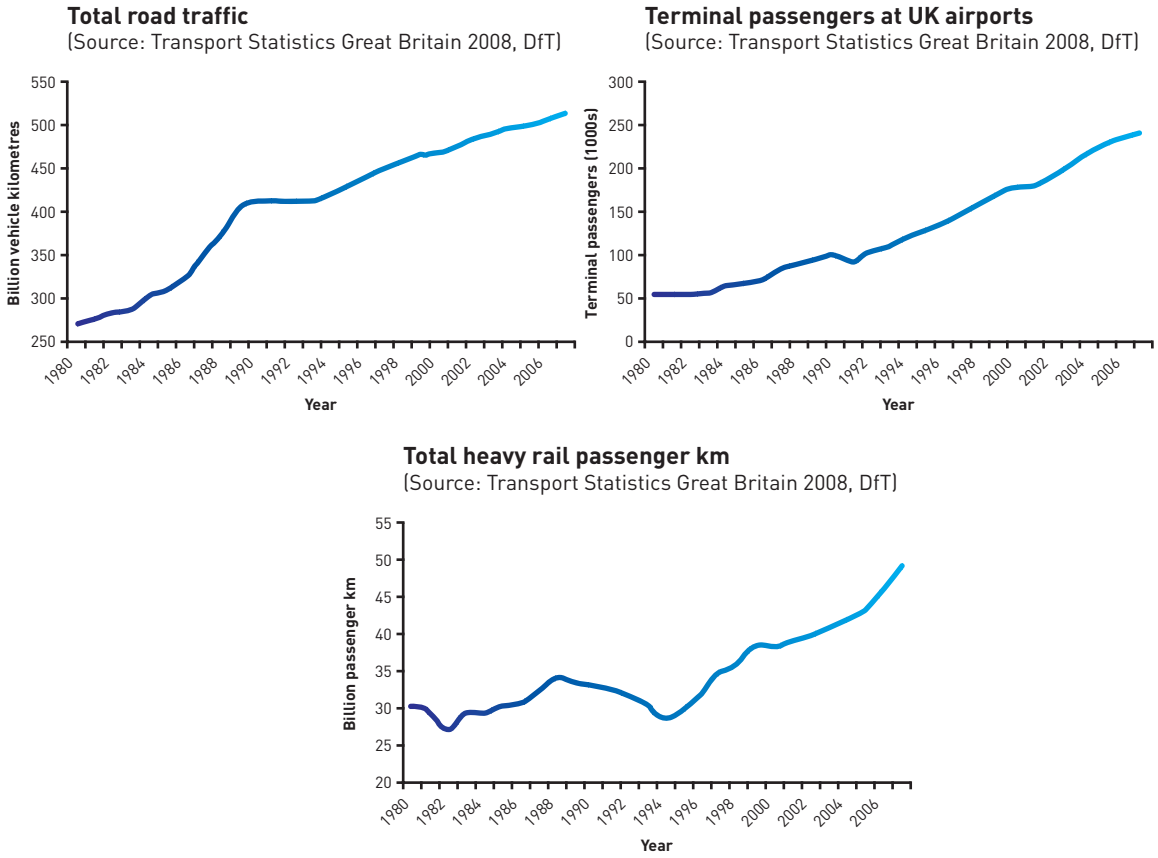


Figure 1.2a Growth in demand for transport
(Source: Transport Statistics Great Britain, 2008, DfT)

1.2.4 This growth has required the infrastructure to support it, which has meant either building new roads, runways and railways, or making the existing infrastructure work that much harder and more intensely. Such intensification has certainly been the case for rail. For example between 1980 and 2007 the length of the total road network grew by around 16%. In contrast the length of the rail network open to passenger traffic grew by only 0.6% over the same period, but now carries 24,000 trains per day, compared to around 16,000 before privatisation.

1.2.5 Despite tough economic conditions in recent quarters, which for a period may act as a brake on growth, over time these trends are likely to continue. In the 2007 Rail White Paper *Delivering a Sustainable Railway* forecasts were made for a 30% rise in rail demand over 10 years. As a result, its chief priority, and that of the 5-year funding plan that accompanied it, was an efficient and short-order increase in the network's capacity, principally by enabling longer trains and tackling the worst network bottlenecks, and thereby increasing the already intensive use of the existing network.

1.2.6 The assumptions made about growth in demand are critical to the appraisal of any transport project business case, which can be highly sensitive to even quite small changes in base assumptions. In recognition of the difficulty in forecasting demand far out into the future, we have capped background demand growth at 2033 in our central modelling scenarios, and these figures take into account the impact of the recession on demand for rail travel (which delays the previously anticipated growth by around 3 years).

1.2.7 Figure 1.2b illustrates, under our central scenario, the forecast average load factors on the WCML in 2033, without the construction of a new line. Load factors refer to the proportion of a train's seats taken up by passengers. Because these figures are given as an average across the day, an average load factor of above 50% indicates a level of crowding on certain peak services.

Figure 1.2b Forecast of average daily load factors on long distance WCML services in 2033

1.2.8 The need to concentrate on improving the performance of the existing network, and in particular on congested urban networks and inter-urban corridors was stressed by Sir Rod Eddington, in his 2006 report to Government:

'the key economic challenge is therefore to improve the performance of the existing network... The strategic economic priorities for long term transport policy should be growing and congested urban areas and their catchments; and the key inter-urban corridors and the key international gateways that are showing signs of increasing congestion and unreliability. Government should focus on these areas because they are heavily used, of growing economic importance, and showing signs of congestion and unreliability – and these problems are set to get significantly worse. They are the places where transport constraints have significant potential to hold back economic growth'[4]

1.2.9 While connectivity may be in place, capacity on any route is finite and there is only so much that can be achieved by incremental, targeted improvements. Moreover – as was demonstrated by the West Coast Route Modernisation – seeking to increase the capacity of an existing railway can be hugely disruptive for the existing route users, both passenger and freight. Both the Eddington Report and the Rail White Paper that followed it held open the prospect that new rail infrastructure would be required in the longer term to tackle those same problems. While underscoring the need for a cautious, evidence-based approach to identifying the right policy measures, and by no means inclined towards high speed rail, Eddington recognised that 'new lines, including new very high-speed lines – should take their place within this range of policy measures, and each should be assessed on their merits'.[5] Likewise the White Paper concluded that proper consideration of new lines would need be to given in order to inform planning for the next 5-year investment period from 2014 and to ensure that any necessary plans were put in place in time to meet the longer term needs of the network.

1.2.10 Since then, the Government has set out its overall approach to transport policy in the policy paper *Delivering a Sustainable Transport System*[6]. As well as explaining and elaborating upon the five key goals for transport (see below), the document puts in place the beginnings of a national framework for long term infrastructure planning – which reflects those goals – by identifying the key strategic corridors and the major conurbations and international gateways they connect. In time the Government intends to produce National Policy Statements as envisaged by the new Planning Act[7]. These will establish the Government's sector-specific policy context within which planning decisions on major infrastructure will be taken. The National Policy Statement on national networks (the strategic corridors referred to above) will set the context in which HS2 will be considered. In Chapter 5 we consider the possible routes for obtaining powers to build HS2, which form part of a wider question about how HS2 might be integrated within the new planning framework.

4 The Eddington Transport Study, 2006 www.dft.gov.uk/adobepdf/187604/206711/executivesummary.pdf
5 Ibid. pg 49 www.dft.gov.uk/adobepdf/187604/206711/executivesummary.pdf
6 Delivering a Sustainable Transport System www.dft.gov.uk/about/strategy/transportstrategy/dasts
7 The Planning Act 2008, www.opsi.gov.uk/acts/acts2008/ukpga_20080029_en_1

The Government's policy goals

1.2.11 In section 1.1 we set out the five objectives for HS2: increasing capacity and improving connectivity; supporting regeneration and growth; creating faster journeys; and encouraging modal shift onto rail. These objectives largely flow from the wider policy goals which the Government has set for transport. In many respects they can be seen as a means to those ends.

1.2.12 Those goals have been defined as follows:

- to support national economic competitiveness and growth, by delivering reliable and efficient transport networks.
- to reduce transport's emissions of carbon dioxide and other greenhouse gases, with the desired outcome of tackling climate change.
- to contribute to better safety, security and health and longer life-expectancy by reducing the risk of death, injury or illness arising from transport and by promoting travel modes that are beneficial to health.
- to promote greater equality of opportunity for all citizens, with the desired outcome of achieving a fairer society.
- to improve quality of life for transport users and non-transport users, and to promote a healthy natural environment.

1.2.13 Some of the links between the specific objectives for HS2 and the wider goals they support are clear from the outset. For example reducing journey times feeds national economic competitiveness and can improve quality of life, while supporting urban regeneration and housing growth can promote greater equality of opportunity and contribute to better safety, security and health.

1.2.14 It is for the Government, ultimately, to determine how far our proposals for HS2 satisfy these goals. It is right, though, that this report should look beyond the specific objectives set for a high speed line and demonstrate how HS2 measures up to the wider goals in question. Indeed, our full evaluation of HS2 adopts DfT's appraisal criteria, which are in turn based on the goals above.

1.2.15 There are also further Government policy goals on which HS2 may have a bearing. The impacts of HS2 would be felt in regions beyond the West Midlands, as journey times are improved to destinations further north, with a possible influence on Government's aim to reduce the gap in economic growth rates between regions. Additionally high speed rail, and the capacity it releases on the classic rail network, will have impacts on land use that in turn may affect the Government's pursuit of growth in the housing supply. These too must form part of the backdrop against which high speed rail is considered.

Previous work on high speed rail and its relationship with HS2

1.2.16 Much work has already been carried out, especially in the last decade, to examine how high speed rail may play a future role in Britain's transport infrastructure, and this forms part of the context in which this report should be read. In addition to a wealth of academic papers on the technical, economic and social implications of high speed rail, there have been several investigations which may be considered in some ways precursors to our own.

1.2.17 At the time HS2 Ltd was established, the most comprehensive of these was a study carried out by WS Atkins on behalf of the SRA in 2002/03 which examined the case for a national network of high speed lines. This extensive piece of work evaluated the business and transport case for high speed rail, configured in various different routes. In essence it concluded that there appeared to be a positive – though not necessarily overwhelming – transport and business case for the indicative routes considered. As part of preparations for the Rail White Paper in 2007, Booz Allen Hamilton were commissioned by DfT to carry out a number of targeted studies, exploring specific issues such as possible cost and carbon impact. These and Atkins' inquiries, together with their supporting evidence, have been made available to us and have since been published by DfT. In parallel, Greengauge 21, a not-for-profit organisation, published a report in June 2007 called HS2, which set out a proposition for a high speed railway between London and the West Midlands with connections to Heathrow Airport, HS1 and the WCML. All these pieces of work have proved useful starting points and we have sought to build upon them where appropriate.

1.2.18 During the course of 2009 the results of two other studies were published. In August 2009 Network Rail reported the findings of the first part of its New Lines Programme, which had begun in 2008 to look at some of the long term options for addressing capacity-constrained rail routes. The resultant Strategic Business Case pointed to a positive case for a new high speed line along the west coast of Britain, serving Birmingham, Manchester, Liverpool and Warrington, Preston, Glasgow and Edinburgh. Network Rail is currently concluding its strategic work on new high speed lines to address capacity constraints on the East Coast Main Line and the Midland Main Line. In September 2009 Greengauge 21 – now sponsored and funded by a Public Interest Group of rail industry organisations, city authorities, regional development agencies, transport partnerships and other authorities – also published its own study which sought to develop an optimal long term strategy for a national high-speed rail network. This work, which was the culmination of a project started early in 2008, argues that a national network of high speed lines – with trunks on the east and west coasts – would be a sound investment and necessary to provide sufficient transport capacity, stimulate a more efficient economy and reduce carbon emissions from transport.

1.2.19 The approach of both Network Rail and Greengauge 21 has been strategic. There are direct parallels with the work we have undertaken to set HS2 within a longer term strategy and we have kept in close touch with both organisations. Collectively the reports present a strong case for high speed rail but examine different network propositions. There are other differences which limit the extent to which direct comparisons between the results can be made. For example varying demand assumptions have been adopted, resulting in different levels of forecast demand. There are also different approaches to mode choice decision making and a range of whole life costs. Neither Network Rail nor Greengauge 21 has modelled our basic proposition for London to the West Midlands with trains running onto the WCML to serve destinations further north.

1.2.20 Clearly, then, there is no shortage of high speed rail studies. But while the findings have been generally positive, none to date has been tasked to move beyond indicative lines and conceptual analysis. Our remit goes further. We have developed and tested specific, buildable route proposals for London to the West Midlands as potentially the first stage of a widespread network and conducted detailed economic and environmental assessments of those plans to understand the localised impact and discussed the options with local authorities and other interests.

International experience and its bearing on HS2

1.2.21 As well as the achievements of HS1 here in Britain, another factor in building momentum for high speed rail in the UK has been the increasing prevalence and apparent success of lines in other nations. Japan and France are well known as pioneers in the development of high speed networks and in recent years Germany, Spain, Italy and China are among those to have followed suit. There are now more than 12,000km of high speed rail in operation around the world and today all but three of the G20 countries are either running, building or planning high speed rail projects.

1.2.22 We have been able to access this rich seam of knowledge and experience and apply it to our work. Where our thinking has been particularly influenced by international experience we have sought to expand on this in the report. For example, as part of our cost forecasting we commissioned a specific piece of work

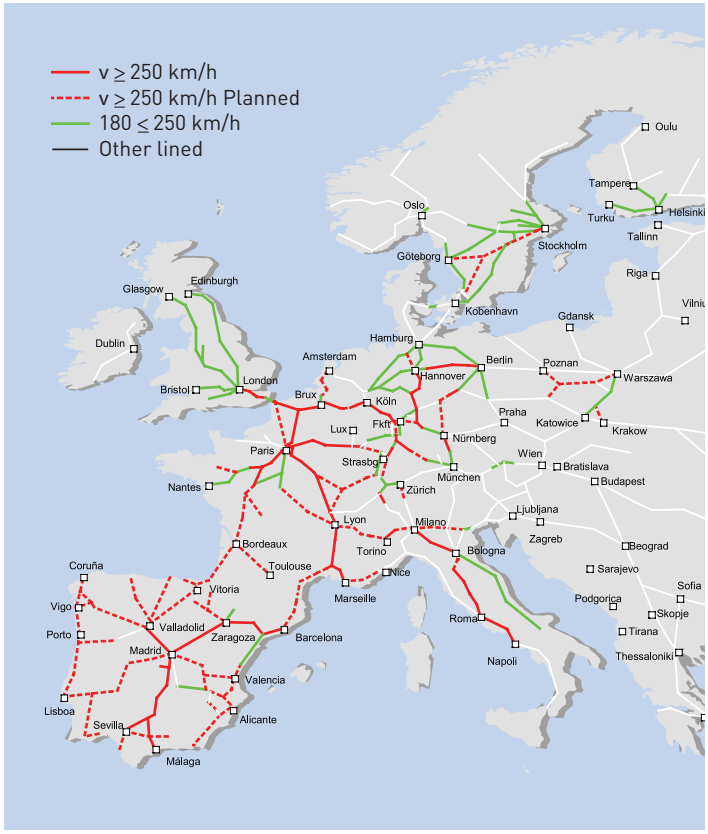


Figure 1.2c Growth of the high speed network in Europe
(Source: UIC, 2008)

to dig deeper into the construction costs of European railways in an effort to understand whether, and if so why, there were genuine discrepancies between UK costs (both projected and actual) and the experience on the other side of the Channel. The findings of this work are set out in the HS2 Cost and Risk Model. We have also held discussions with operators such as Eurostar, Central Japan Railways, SNCF and Deutsche Bahn which have informed our thinking on a wide range of issues such as station location and whole journey integration.

1.2.23 We have also benefited from a review of international experience conducted by Terry Gourvish – *The High Speed Rail Revolution: History and Prospects* – which is published alongside this report. The review highlighted the fact that – beyond the common factor of speeds over 200kph (125mph) – the implementation of high speed rail around the world has varied according to particular circumstances and led to a diverse range of high speed rail 'models'. Four in particular demonstrate the different possibilities. The UK will need to decide which model, or combination of models, to follow.

Japan

The first Japanese 'Bullet' train – the *Tōkaidō Shinkansen* – opened for service in 1964, running between Tokyo and Osaka. Since then a network of lines has been built across Japan, on which over 150 million journeys were made in 2008.

The Shinkansen is perhaps the best illustration of the radically different service that high speed rail can offer, far removed from the classic rail we are used to. The *Tōkaidō* line operates a very high frequency timetable, with services departing every 3-5 minutes. A small number of these are stopping trains, which use loops off the main line to serve stations roughly 20km apart. But the bulk of services run at high speed, stopping only twice before their destination. The very precise integration of fast and slow services is permitted by the exceptionally high performance and reliability of the trains and infrastructure, which result in an overall average delay of less than thirty seconds. That is partly achieved by the total segregation of the line from other networks, which insulates it from disruption elsewhere, and the exclusion of freight. Segregation is also largely responsible for the zero casualty rate among the 6 billion passengers who have used the network over the course of its life.

Great lengths are also taken to reduce the level of maintenance required, with lighter trains causing less wear and tear. As a result all maintenance is carried out overnight, between midnight and 6am, meaning that a full seven-day, all-day service can operate. It needs to, such are the levels of demand for rail travel in Japan. The *Tōkaidō Shinkansen* connects Japan's two largest metropolitan areas – Tokyo and Osaka-Kobe-Kyoto, which together comprise some 53 million people, and generate almost £1trillion in GDP. Between Tokyo and Osaka – a 3 hour journey over a line distance of 515km – the 1,300 seat capacity bullet train captures around 67% of the overall market.

Terminal stations in Japan therefore have to cope with up to 2,600 passengers arriving and departing every few minutes at peak times and do so thanks to exemplary operational discipline and innovations such as 'open' ticket gates, which close only when an invalid ticket is presented and luggage-advance services which reduce the delays caused by the handling of bulky baggage. Effective passenger information systems and highly efficient train dispatch help to preserve the Shinkansen's reliability and punctuality.

France

The first TGV line opened between Paris and Lyon in 1981, and since then another 6 lines or extensions have been built, with a further 4 under construction and as many as 6 more planned for the future. The network has been constructed in sections, with Paris as a hub, and now comprises around 1850km, of which the more modern lines are engineered for speeds of 320kph (217mph).

As in Japan, high speed rail has proven to be hugely popular in France. The TGV has become part of the national identity, used by 90 million passengers every year, and in preference to other modes – 91% of journeys between Paris and Lyon are made by TGV.

The French model is quite different from Japan, characterised by a less frequent service pattern (for example 22 trains per day between Paris and Lyon), and city-to-city journeys with very few intermediate stations. Where intermediate and parkway stations have been built, their fortunes have been mixed.

Another big difference is that TGV trains run off the high speed lines and on to the existing classic rail network – much like the Eurostar trains used to before HS1 opened. In this way the benefits of high speed can be spread much further afield, and when the population is distributed more sparsely, as it is in France, this becomes a critical capability.

Germany

Germany is almost twice as densely populated as France, but with many more significant urban settlements and no real hub such as London or Paris. As a result its high speed network has developed into much more of a 'web', with relatively short sections built incrementally, a greater number of stations and a lower average speed in consequence. Today there are over 1250km of high speed rail in operation in Germany – although only around 700km is built for speeds over 250kph (155mph).

Various fleets of ICE trains provide national and international services on both high speed (in this case 300kph) and conventional lines. There are also conventional trains equipped to tilt – enabling speeds of up to 230kph – on the conventional lines (similar to tilting trains on the West Coast Main Line). Many of Germany's high speed lines make use of both high speed sections and conventional running - for example the true high speed line between Cologne and Frankfurt actually begins at Cologne-Porz, around 8km outside Cologne, and ends at Frankfurt Stadium, on the outskirts of that city.

Also some routes have been designed for mixed use (either high speed plus freight or high speed plus classic passenger trains). This has been followed where passenger flows were not sufficient to warrant frequent high speed services to use up the new capacity. Conversely on the Cologne-Frankfurt line, where passenger flows were sufficient to justify frequent high speed trains, the route was dedicated solely to high speed use.

Spain

In Spain, the high speed network is centred on Madrid, with lines to Seville and Malaga, Barcelona, and Valladolid forming the core of the network. This network is used by two main types of services:

AVE (Alta Velocidad Española) services link the major cities on the high speed network. They operate at up to 330 kph (205 mph), and have radically reduced the journey times on these routes. These trains are confined to the high speed network.

Alvia services continue beyond the limits of the high speed network, to serve those cities which this network has yet to reach. They operate at a maximum speed of 250 kph (155 mph) on the high speed lines, and at lower speeds on conventional routes. As the track gauge (the distance between the rails) of the conventional network in Spain is significantly greater than the standard gauge used on the high speed lines, these trains are equipped with variable gauge bogies.

The comparatively low service frequency on the Spanish high speed lines permits AVE and Alvia services to share the same lines, despite the difference in maximum speeds.

1.2.24 In the next chapter we explain both the model of high speed rail that we envisage in operation in the UK, building on these examples from around the world, and outline the approach we have taken to examining the case and developing proposals for high speed rail's further expansion in the UK.