



Prepared by:

Steer Davies Gleave
28-32 Upper Ground
London SE1 9PD

+44 20 7910 5000
www.steerdaviesgleave.com

Prepared for:

Department of Transport
Great Minster House
33 Horseferry Rd
London, SW1P 4DR

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Summary

Context

High Speed 2 (HS2) will deliver a step change in capacity and connectivity on the UK's long distance rail network. By providing direct intercity services on dedicated high speed lines, it will release capacity for new train paths on the congested West Coast Main Line (WCML) and East Coast Main Line (ECML). This presents a once in a generation opportunity to radically rethink how passenger and freight services are delivered on these corridors – and on the Midland Main Line (MML).

There is the potential to deliver additional **capacity** on existing routes and improved **connectivity** between places where service patterns are currently constrained by the need to accommodate a mix of long distance and local passenger and freight services.

Steer Davies Gleave was commissioned by the Department for Transport to examine and analyse options for making use of this released capacity on the existing routes as Phase 2b of HS2 opens, when long distance services between London/Birmingham and Manchester/Leeds (and other northern destinations) will transfer to the new HS2 infrastructure. Attention is also given to the impact of Phase 2a, which extends the first phase project northward from Lichfield to Crewe.

Our starting point for reference purposes was the HS2 specification and assumed services on the existing network, as described in the Strategic Case. We identified a set of candidate changes to these assumptions that represent differing ways of using capacity released by HS2. Six alternative **scenarios** were defined to address target travel markets that could be better served by the existing network once long distance demand shifts to HS2. These scenarios are **illustrative** of how the released capacity could be used amongst a broad spectrum of options and further consideration will need to be given to these opportunities as part of planning best use of the future railway.

No commitments to future year service levels – on HS2 or on the wider railway – have yet been made, so all the work described here should be regarded as an exploration of the possibilities arising from HS2, rather than firm plans or commitments.

Background

The existing rail network is increasingly heavily utilised, both in terms of track capacity (the number of trains per hour that each section of line can accommodate) and passenger capacity (the number of passengers carried on each train). Track capacity can be increased by selective infrastructure improvements such as additional tracks, improved signalling and grade separation, but the works can be disruptive and costly. In practice, implementing such improvements is often difficult, given the high levels of utilisation of today's network. Passenger capacity can be increased by running longer trains, but this also has practical limits imposed by platform lengths, particularly in the London commuter area. Elsewhere, local trains tend to be shorter, but there are still constraints on train length at minor stations (where platforms may be short and difficult to lengthen) and at major ones (where multiple occupancy of platforms is often necessary).

Improvements in connectivity can stem from new services, better connecting timetables and speeded up services.

Growth in the demand for rail travel is forecast to continue, and with the limits of track and passenger capacity being reached or approached on many lines, alongside ambitions for better connectivity, there is a need to provide additional capacity. Along key routes into major cities, HS2 Phase 2b provides the means to address this need, not only through the new line capacity but also through the space freed up on existing up on the existing network. Indeed, the work carried out here shows that connectivity and journey times can be improved widely across the national rail network, not just for stations served by HS2.

By establishing a new parallel route for faster, more efficient and more reliable long distance passenger travel, HS2 increases the aggregate capacity and capability of the rail network. This increase can be measured in the first instance by the number of seats per hour it is planned to provide on HS2 trains travelling over the new HS2 infrastructure. HS2 Phase 2b provides significant additional capacity into London, Birmingham, Manchester and Leeds, with services that will be used by long distance travellers. And services used by these travellers will no longer need to run on the existing network (or can be usefully adapted to address other travel markets), freeing up track capacity for other services.

The choice of improvements in capacity, journey times and connectivity on the existing network is a complex matter, with options on service development extending to freight as well as passenger services. While these choices are yet to be taken (and it would be inappropriate to try to set a timetable for services this far ahead of their adoption in 2027/2033), it is already clear that there will be widespread benefits. The number of places that will benefit from HS2 are greatly extended beyond those served by HS2 train services. These benefits, while based on services that will not be finally specified until later, should nevertheless be recognised as forming part of the overall investment case for HS2.

Alongside capacity and connectivity gains, there is the possibility that the capacity released on the existing network by HS2 could also be used to create more 'white space' in the timetable that, with less risk of delays on one service affecting others, could bring about an improvement in service reliability. While none of the scenarios specifically attempt to create, and measure such gains, they each feature timetables with less variability in train speeds and are therefore likely to be conducive to improved service reliability.

How Capacity is Released by HS2

In terms of released capacity, there are two effects to consider:

- changes to the train services operating on the existing network; and
- reduced occupation levels on remaining long distance services on the existing network (with passengers having transferred to HS2), releasing more seats for other passengers, especially those joining/leaving at intermediate stations.

The first effect takes advantage of the removal of non-stop long distance *trains* on today's crowded network, with a shift towards other types of service (local or regional). This change means that increased seating capacity can be provided at places on existing lines currently served only by local/regional – but not long distance intercity services. The capacity available for

commuters and other shorter distance travellers is thereby increased. But this is not the whole picture.

With fast end-to-end journey times between London, Birmingham, Manchester and Leeds (and key destinations further north) provided by trains using HS2, remaining longer distance services on existing routes can be re-focused on improving connectivity for places that are not served, or are poorly served, by the current timetable priorities.

So, in summary, it becomes possible *either*:

- to insert additional stops in long distance services, improving capacity and connectivity across the network, with new journey opportunities; *or*
- to provide services to new destinations or increase levels of service to destinations that currently have only infrequent or irregular services, improving connectivity and journey times.

In addition, by removing or reducing the need to mix non-stopping with stopping trains on the same line, it is likely to be possible to increase the total number of trains per hour that can be accommodated.

The second released capacity effect is related to the diversion of *passengers* to HS2. By shifting long distance passengers off services on the existing network, HS2 Phase 2b will release seats on remaining long distance services. These can be used by travellers from places not served directly by HS2 and, more generally, by regional/local passengers. A good example of this type of gain is Wakefield – London. Currently, Leeds - London trains call at Wakefield, with, at busy periods, high levels of seat occupation by passengers travelling from Leeds (and other locations in West/North Yorkshire) to points south. With HS2 Phase 2b, most of these travellers will have switched to using the faster HS2 services, releasing a very substantial increase in seat numbers for passengers starting their journey at Wakefield on remaining London trains. The magnitude of this type of beneficial effect is *not* covered in this report (which is concerned only with the supply of seats, not their occupation patterns).

HS2: Capacity Released in Phases

HS2 Phase 1 will provide a dedicated route for long distance passenger services between London, Birmingham and Handsacre (north of Lichfield on the Trent Valley line). The capacity on the WCML released by Phase 1 has been the subject of earlier assessments in the Strategic Case work and is not covered again here.

When Phase 2a opens, long distance passenger services will be able to operate over the dedicated high speed line from London Euston to just south of Crewe. This could remove up to seven trains per hour (tph) in each direction from the existing network between London and Crewe, releasing capacity for more passenger and/or freight services along the Trent Valley.

Phase 2a provides the context for our examination of the potential capacity released when the full extent of the network to Manchester, Leeds and York is delivered by Phase 2b.

HS2: Connectivity

HS2 will deliver significant connectivity improvements between major cities, in terms of speed, frequency and connections. It also presents an opportunity to improve the connectivity of stations and places that will not be directly served by HS2 trains. These include:

- intermediate towns and cities on the WCML and ECML, where services may be limited in today's timetable by the need to prioritise non-stopping long distance services; and
- stations that lie on branches of the WCML and ECML with current through services constrained by capacity on the main lines.

Current timetables provide contrasting connectivity between intermediate stations on the WCML and ECML. On the former, the semi-fast Crewe service operated by London Midland provides regular interval connections between all stations from Rugby to Crewe via Stoke, though a change of train is required to reach destinations further north. On the ECML, calls at intermediate stations (Grantham, Newark and Retford) are provided by long distance services on a rotating basis, resulting in inconsistent and sometimes infrequent links between these intermediate stations and between them and northern destinations.

Stations on branches of the main lines could benefit in three ways from revised service patterns enabled by HS2: first through the provision of new direct services to London, second through more regular calls at the junction stations, enabling more frequent opportunities for interchange trips and third through the introduction of new long distance cross-country services.

Phase 2b Released Capacity Scenarios

The scale of improvement on the existing network depends on choices made on timetables and rolling stock types. Each of the scenarios tested focused on different ways to structure passenger services to deliver capacity, connectivity and journey time benefits or to add freight services on the existing network post-HS2 Phase 2b.

Six scenarios were developed and explored:

1. **Regular Interval Timetables:** Enhancing London services for the principal intermediate stations on the WCML and ECML, providing a higher frequency service between these stations and much improved cross-network connectivity;
2. **New London Destinations:** Introducing new London intercity services and/or improving services to stations that currently receive fewer than 4 return services a day;
3. **Recast Cross-country:** Taking a strategic look at the existing long distance Cross-Country network and identifying opportunities to enhance existing services and (where feasible) extend services to new markets. This opportunity arises in part because the eastern leg of HS2 Phase 2b follows the key NE/SW Cross country corridor;
4. **London Commuter:** Enhancing commuter services on the ECML and considering extensions to new destinations in peak hours (Note: WCML London commuter services fall outside the scope of this study as they are delivered at Phase 1 of HS2);
5. **Enhanced Regional/Local Services:** Reflecting initiatives and ambitions of sub-national bodies to enhance local and commuter services into Birmingham, Manchester and Leeds; and

6. **Freight:** Using released freight paths to add new long distance freight services on the WCML and ECML.

Hybrid solutions, which mix the six scenarios, are of course possible and in practice, given the need to balance differing market opportunities, may be adopted in due course rather than a single scenario. There is particular scope to:

- combine Scenarios 1 and 2 – with long distance services to London serving new destinations *and* providing better, more regular, intermediate station coverage;
- combine Scenarios 3 (or 5) and 4 – with additional cross country or local/regional services using the ECML north of Peterborough *and* more London commuter services using the route south of Peterborough, effectively using a single long distance path for two services;
- combine Scenario 6 with Scenario 1, using the reduced differentials in journey times to create more train paths.

In each passenger service scenario examined, the additional capacity delivered on HS2 Phase 2b itself is taken as fixed, and we focus on the effects on the existing network. In fact, there is some spare capacity on each part of the HS2 Phase 2b network itself, and we summarise this additional prospective benefit at the end of this chapter.

Conclusions

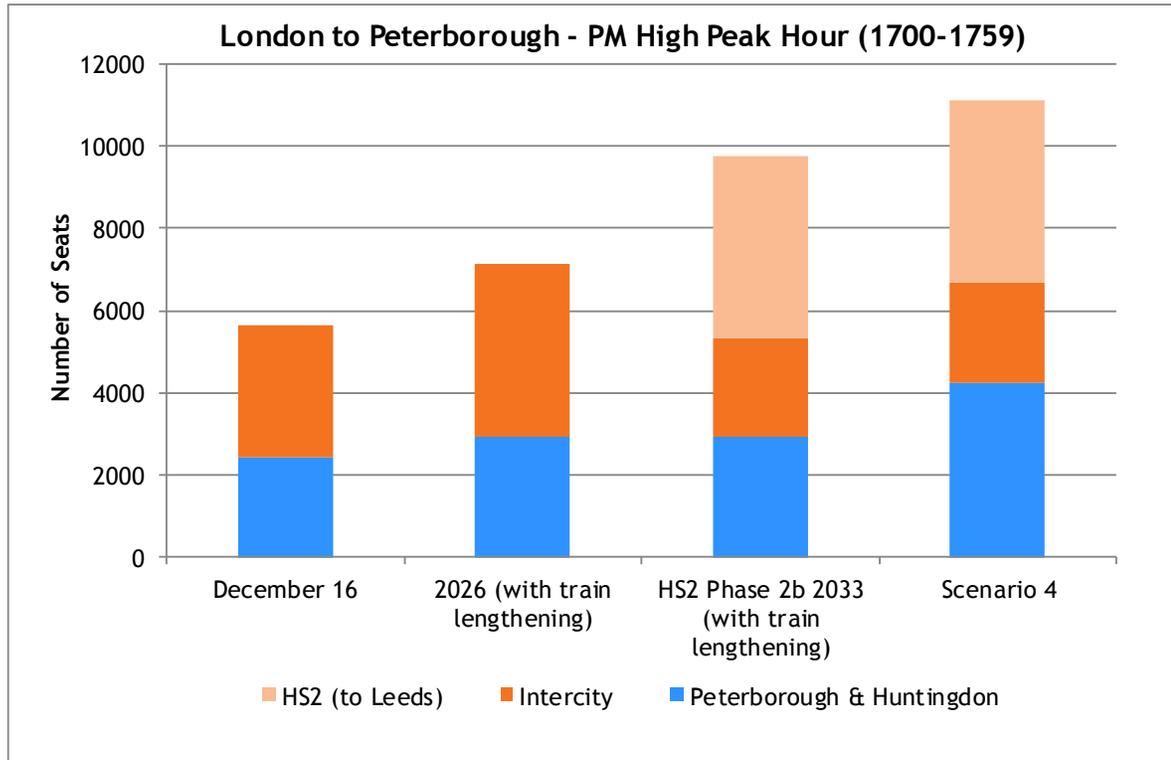
Capacity

Across the scenarios, uplifts in total seated capacity on the key corridors are achieved in the first instance by the addition of HS2 services. Then, with HS2 Phase 2b in place, it is possible to re-distribute capacity on the existing network from long distance, non-stopping, intercity services to the provision of services that better meet local and regional needs.

The examination of service options in Scenarios 4 and 5 indicated that significantly more commuting capacity can be provided into London (Kings Cross) on outer suburban services. Evening peak commuting capacity on the London-Peterborough corridor can be increased by 19% under Scenario 4 compared to 2016 timetable. This is despite track capacity already being close to 100% utilised in the peaks, and is achieved by replacing some intercity trains with services operated by higher capacity suburban rolling stock.

Taking into account the capacity that HS2 will itself provide to current ECML destinations further north, capacity in this corridor from London can be increased by 97% under Scenario 4.

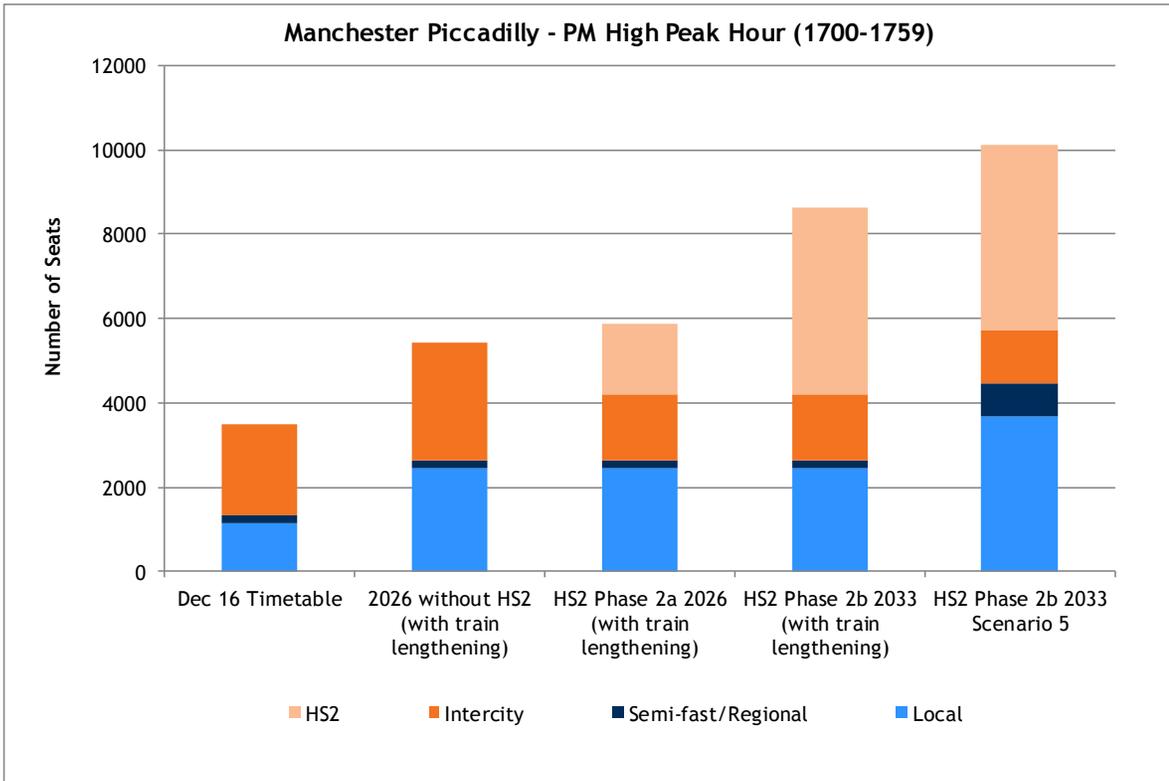
Seating capacity from London on the ECML under Scenario 4



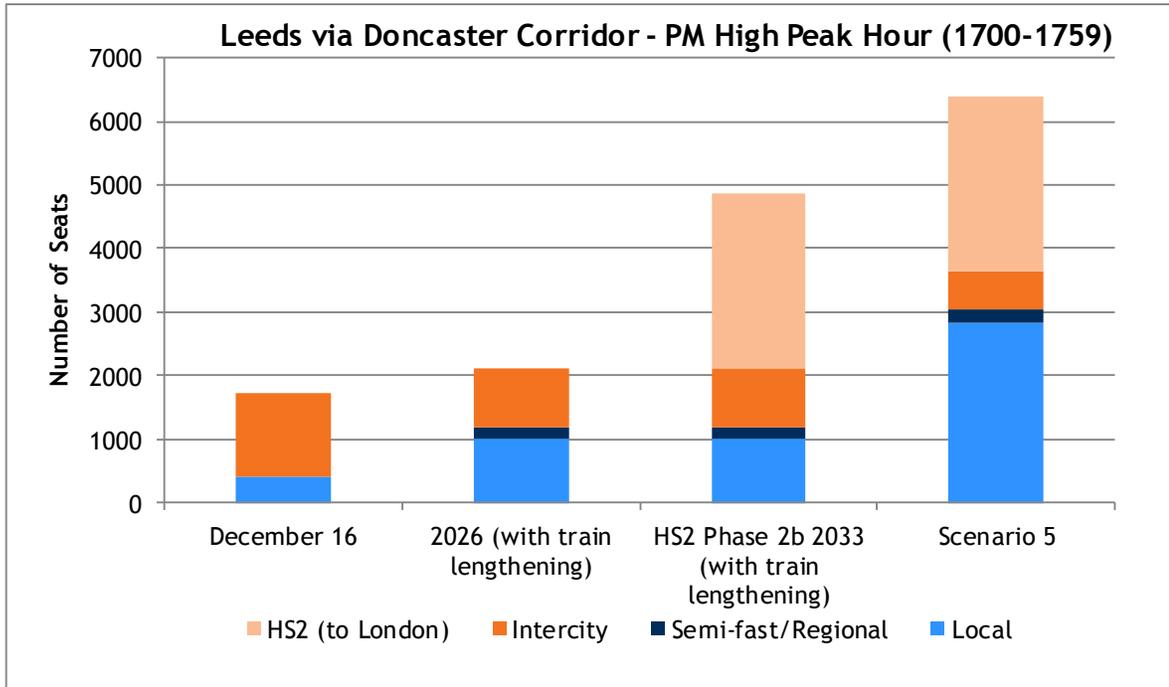
The extra London Commuter capacity could be allocated to Peterborough services or to the Cambridge line, subject to the availability of paths on the latter. The Cambridge option might be preferable, since the ECML through Peterborough will also benefit from reductions in demand originating further north, freeing seats for local passengers, whereas the Cambridge line will not.

In Scenario 5, the numbers of seats on local and regional trains into Manchester and Leeds show significant increases along the HS2 corridors which, in each case, approach these cities from the south. Manchester local services (through Cheadle Hulme) would gain an uplift in capacity of around 165% in the morning peak, 220% in the evening peak and 330% in the off peak (compared with 2016 seating provision). Local service on the route from Leeds via Doncaster has capacity gains of around 180% in the morning peak, greater than 500% in the evening peak and around 160% in the off peak, again compared with 2016. There are also increases in capacity from Crewe & Runcorn into Liverpool as a result of HS2 Phase 2a.

Seating capacity from Manchester on the Crewe and Stoke corridors in Scenario 5



Seating capacity from Leeds in Scenario 5



Phase 2b Connectivity and Journey Times

The adoption of regular interval timetables on the WCML and ECML (Scenario 1) improves connectivity at intermediate stations along these routes. On the WCML, for instance, it is possible to provide direct services from Rugby/Nuneaton/Tamworth/Lichfield to Manchester that cannot be operated today, shortening journey times by around 30 minutes. On the ECML, major improvements are possible at the intermediate stations of Retford (from which services to both London and Leeds could be made 15 minutes faster) and Newark (which could gain a 30-minute speed up on services to Leeds).

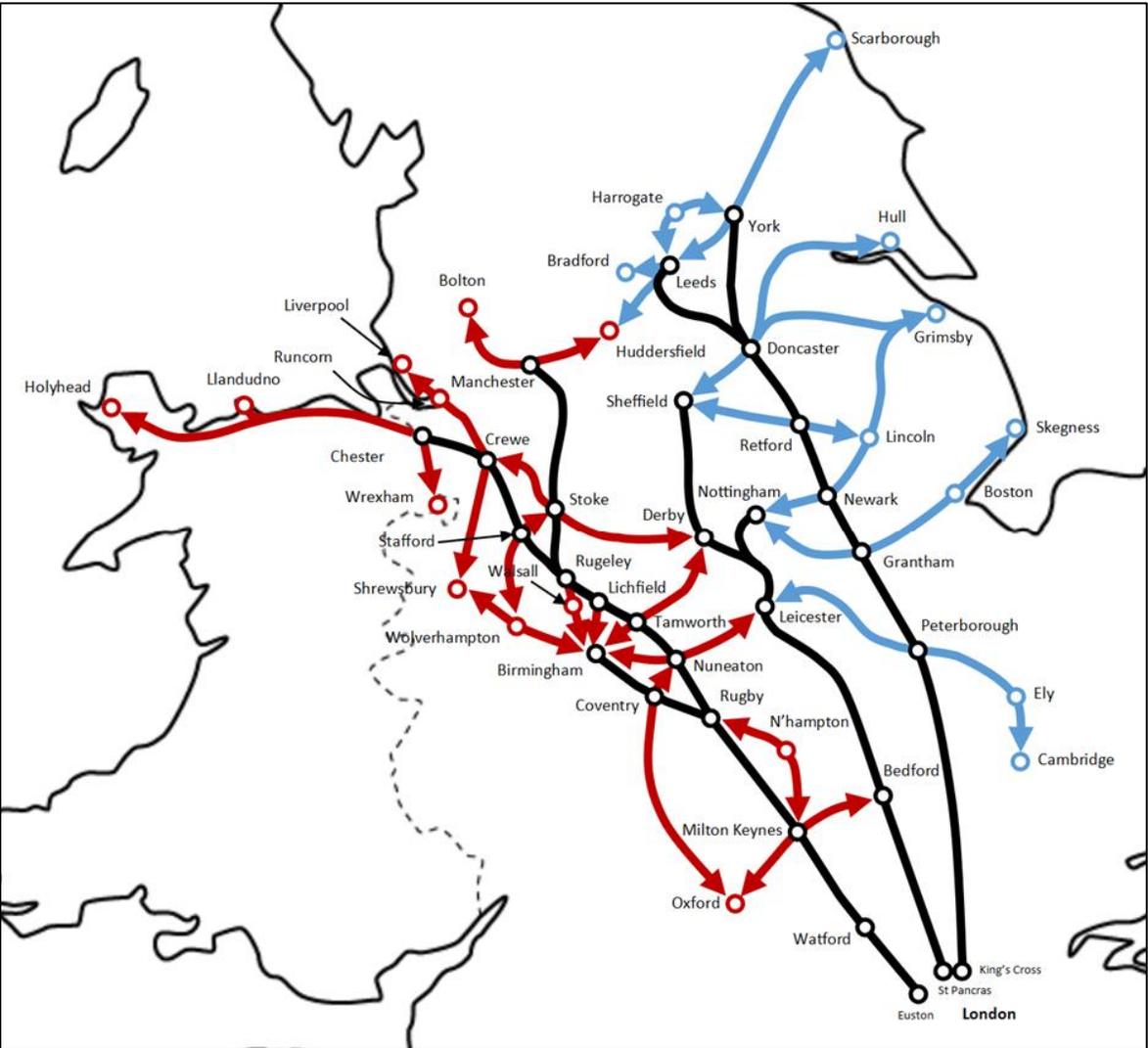
Improving service frequency for immediate stations on the WCML and ECML with a regular interval timetable (rather than, in the case of East Coast, the 'skip-stop' service on longer distance trains provided today) could also dramatically improve interchange opportunities into connecting east-west services:

- Tamworth – services to Burton upon Trent, Derby, Nottingham, (and further afield: Yorkshire, NE and SW England and South Wales);
- Lichfield – services to Sutton Coldfield and Redditch;
- Rugeley – services to Walsall and Hednesford;
- Newark – services to Nottingham, Lincoln and Grimsby;
- Retford – services to Worksop, Sheffield, Gainsborough and Lincoln.

Improving intermediate connectivity along the WCML and ECML can therefore help to create a regional rail network, no longer confined in each case to a single linear corridor but serving places

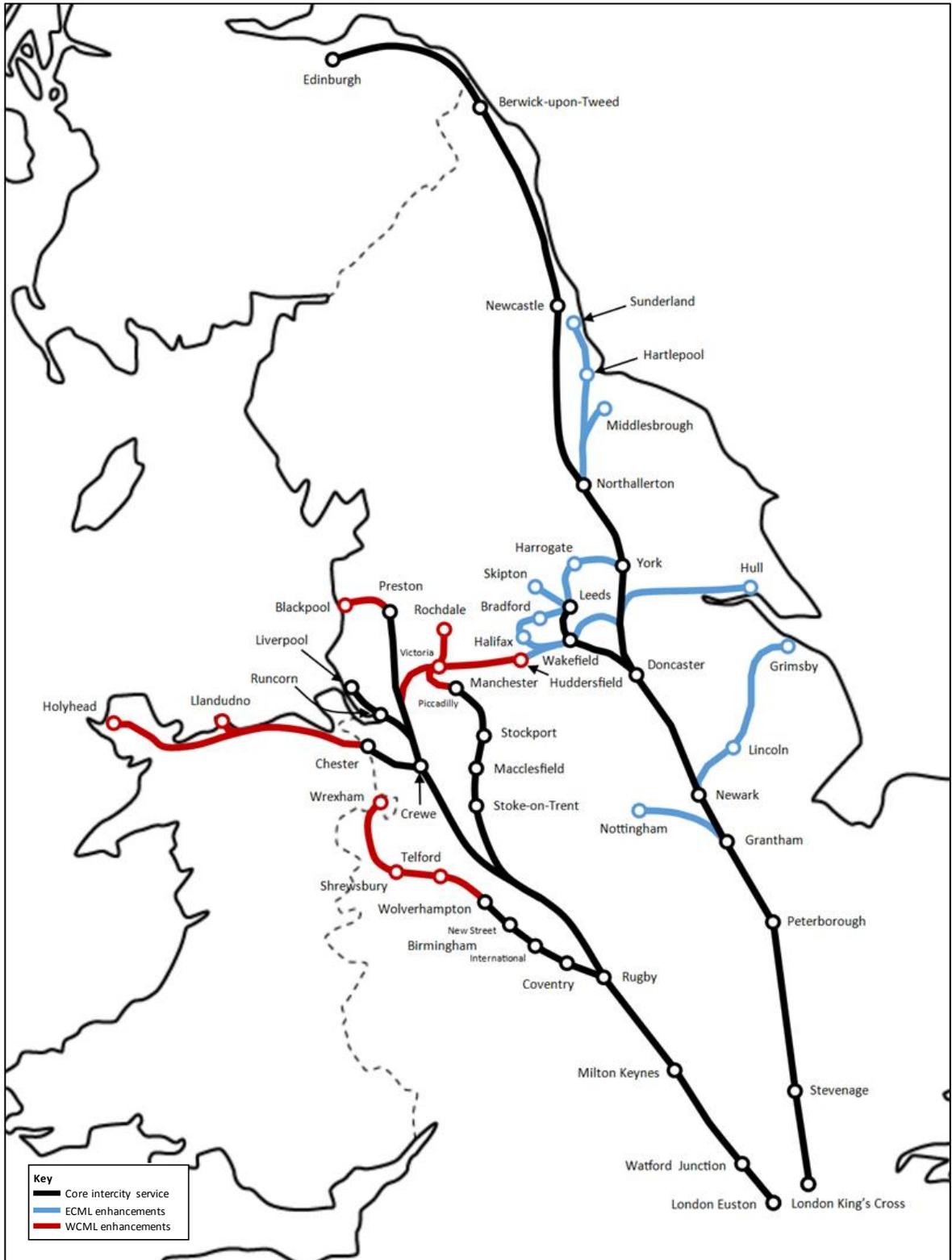
across the East and West Midlands much more widely. This would broaden the appeal of rail as a realistic alternative to car use – see indicative network connections below.

Indicative network connections in East and West Midlands



Another way to improve connectivity that has been examined is using released capacity from HS2 Phase 2b to improve long distance connectivity between London and destinations that are either not currently served or served irregularly (Scenario 2, see figure below). This could potentially bring over a million people within reach of direct London services, enabling them easier and faster access to the capital. It could also provide a more frequent service for over 3 million people across the Midlands, Northern England and North Wales.

Indicative long distance connectivity



The service changes under-pinning this improvement in connectivity (tested in Scenario 2) are shown in the following table.

Enhanced long distance connectivity to London on existing lines

Origin	Destination	Dec 16 Timetable Service Frequency	Dec 21 Timetable Service Frequency (ECML)	HS2 Phase 2b Scenario 2 Potential Service Frequency
Shrewsbury	London Euston	2 trains per day		Hourly
Wrexham	London Euston	1 train per day		Hourly
Chester	London Euston	Hourly		Half-Hourly
Holyhead	London Euston	6 trains per day		Hourly
Blackpool	London Euston	1 train per day		Hourly
Rochdale	London Euston	No direct services		Hourly
Bradford Forster Square	London Kings Cross	1 train per day	Two-hourly	Hourly
Sunderland	London Kings Cross	6 trains per day	7 trains per day	Hourly
Nottingham (via Grantham)	London Kings Cross	No direct services	No direct services	Hourly
Harrogate	London Kings Cross	1 train per day	Two-hourly via Leeds	Two-hourly via York
Hull	London Kings Cross	Two-hourly	Two-hourly	Hourly
Lincoln	London Kings Cross	1 train per day	Two-hourly	Hourly

The two approaches to improving connectivity (examined in Scenarios 1 and 2) could be combined: adding in longer distance connectivity to London for places *off* the main line with additional connections *along* the main line). Another approach examined (Scenario 3) looked at better cross-country services. While only 3% of the Cross-Country's current passenger flows would be served directly by HS2 in future (reflecting the rich variety of short and longer distance flows handled by this franchise), HS2 Phase 2b creates opportunities to develop new cross country services making use of the East and West Coast Main Lines and the Midland Main Line. These could include services such as Leeds – Cambridge (which conveniently leave scope to increase separately commuter capacity south of Peterborough – as in Scenario 4).

Freight

Network Rail's most recent railfreight review suggests an annual growth rate of 3% in tonne-km terms between 2011 and 2033 notwithstanding the loss of coal traffic. The scope to operate longer as well as more freight trains is being considered.

The opportunities to use the capacity released by Phase 2 of HS2 on the WCML and ECML for additional freight flows are limited by capacity constraints on other parts of the rail network. At present, across the day, there is an average of one freight train on the WCML between London and Rugby (and on to Crewe via Nuneaton) in each direction: typically, northbound, two paths per hour are used in mornings and early afternoons but none in the later afternoon and early evening during the London homeward commuter peak.

HS2 has the potential to free up enough capacity to introduce one further train path each hour on this corridor, and in Phase 1, this could serve freight flows between the London area and the West Midlands. With Phase 2a, the capacity gain extends to Crewe. Subject to signalling renewal plans for the Crewe area currently planned for completion during Control Period 6, it would be possible to add freight capacity between Crewe and Weaver Junction. This would mean that from Phase 2a completion in 2027, the additional freight capacity on offer would extend from London to the Liverpool area in which there are several important freight terminals.

On the WCML north of Weaver Junction to Scotland, the key opportunity would be to switch freight traffic to electric haulage (or possibly double-hauled diesel locomotives), reducing freight journey times.

Capacity released on the ECML could be used to serve intermodal flows from East Anglia and the Thames Gateway to Yorkshire and North East England. Although capacity and capability for freight on the non-electrified route between Peterborough and Doncaster via Lincoln has been increased in recent years, access to this line is limited without the benefit of grade separation of key junctions.

Capacity available on HS2 itself

The two legs of HS2, when built, will have some spare capacity – 2 train paths/hour on the western leg north of Birmingham and 4 train paths/hour on the eastern leg north of Birmingham¹. Subject to there being sufficient demand, there would be scope to use this to add further passenger services beyond those assumed in the HS2 economic appraisals, enhancing connectivity and capacity further and adding to project benefits. Increasing service levels will have to be weighed against the performance impacts of increasing capacity utilisation.

On the western side, there is the possibility of introducing a Liverpool – Birmingham HS2 service, speeding up the journey time between these two cities significantly. Depending in the detail of arrangements at the planned Crewe Hub station, it would also be possible to add further services onto the Phase 2b leg between Crewe and Manchester (Piccadilly). Where these additional services use relatively short sections of HS2 (as in the case), use of 230km/h 'Javelin-style' rolling

¹ Some of these paths may not extend all the way to Birmingham Curzon Street and any decision to use the spare capacity would need to consider the impact on other HS2 services and overall performance of HS2.

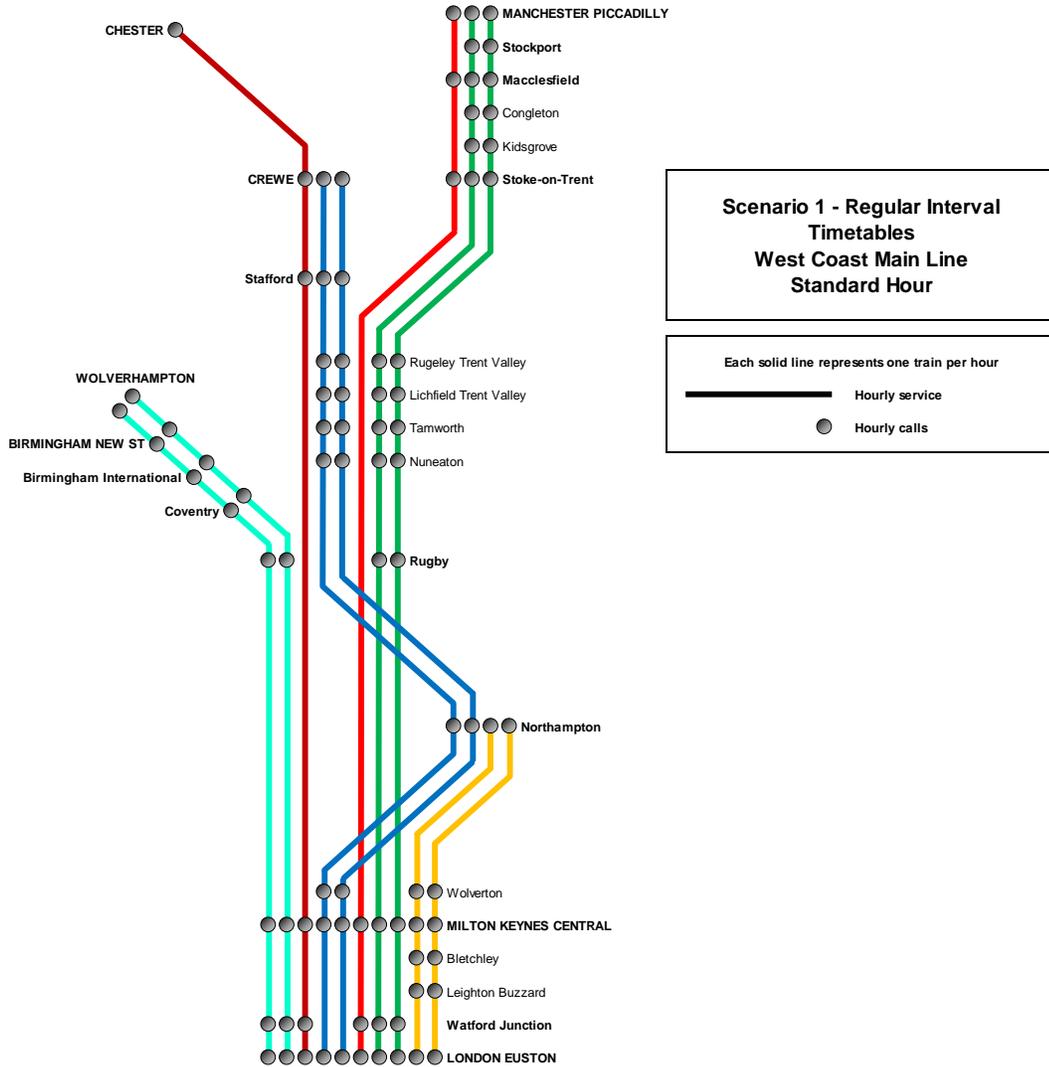
stock would be acceptable since there would little impact on overall route capacity. Transport for the North are also investigating options for Liverpool to Manchester services which could involve using part of HS2.

Spare capacity could be used in the case of the Leeds – Sheffield section of HS2 Phase 2b where it is a key aspiration of Transport for the North to improve journey times and connectivity. Four fast trains per hour would appear to be achievable over this section, with a variety of service concepts possible.

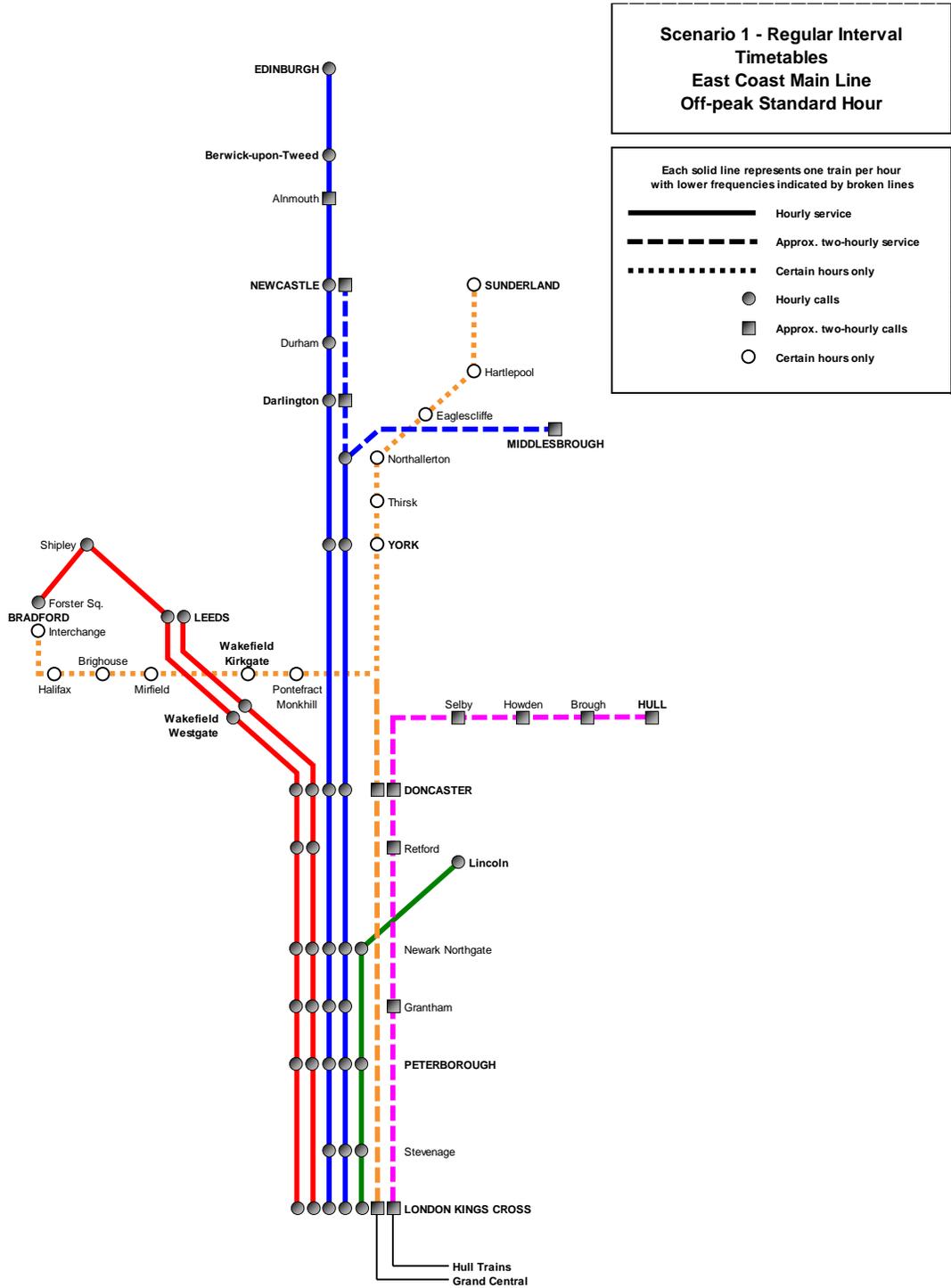
More generally on the eastern leg, additional services to/from Birmingham Curzon Street would be possible, including a fast service to Leeds (in addition to those running *via* Sheffield) as well as serving new destinations that can be reached *via* Sheffield. There are also other potentially valuable options identified that become possible with some adaptations either to the HS2 service concepts or if additional connectivity to the existing network is provided.

A Released Capacity Scenario Schematics

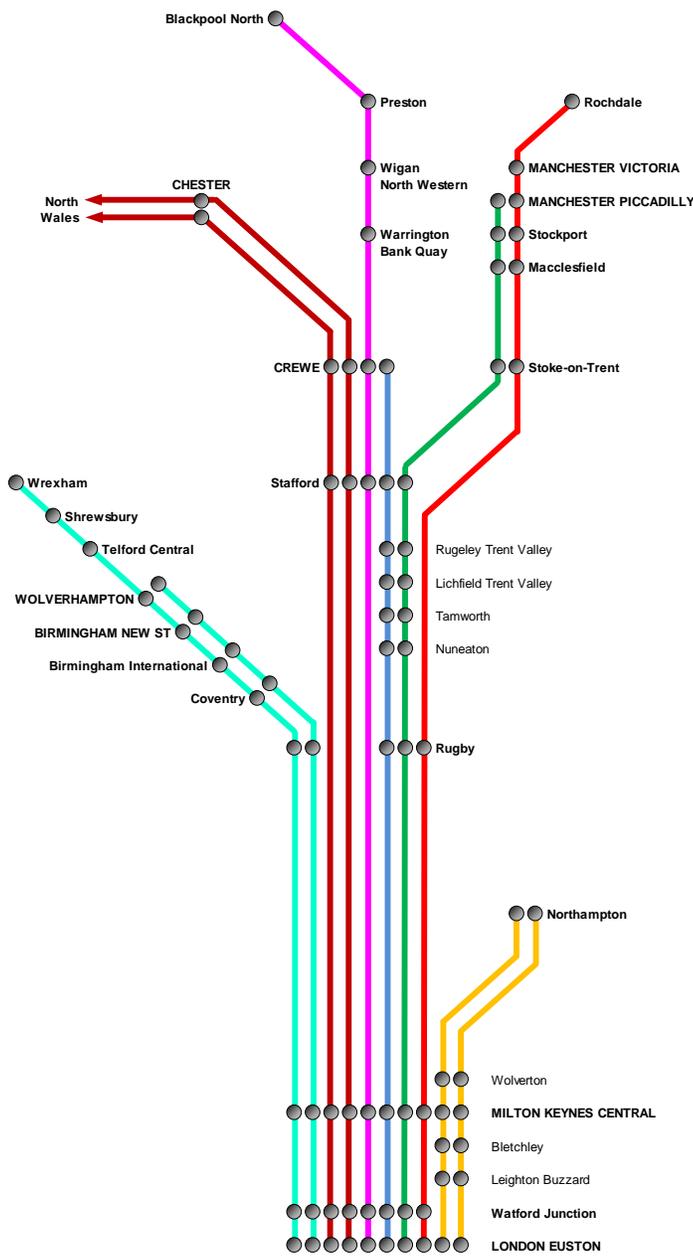
Scenario 1 – WCML Regular Interval Timetable



Scenario 1 ECML Regular Interval Timetable



Scenario 2 WCML New London Destinations

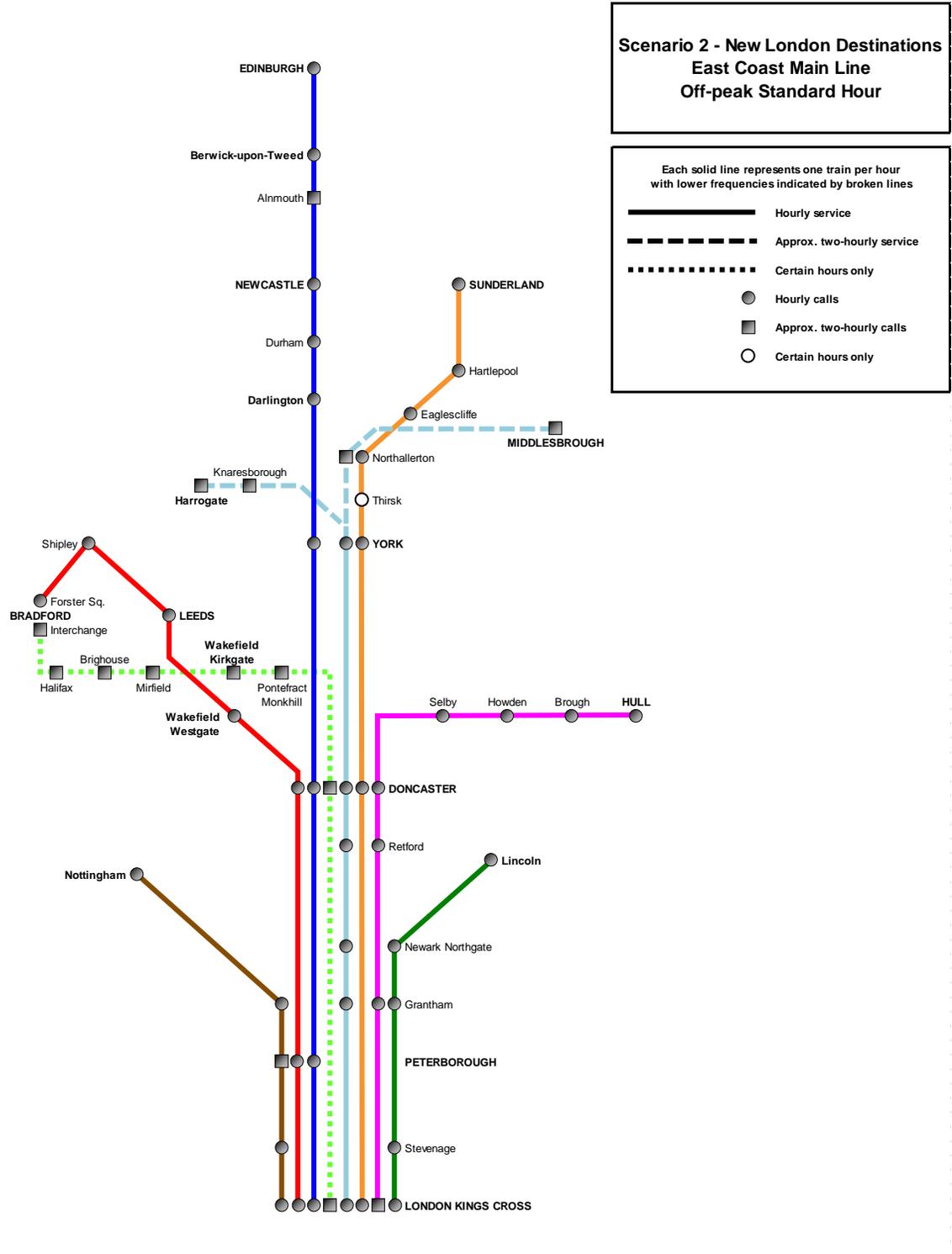


**Scenario 2 - New London Destinations
West Coast Main Line
Standard Hour**

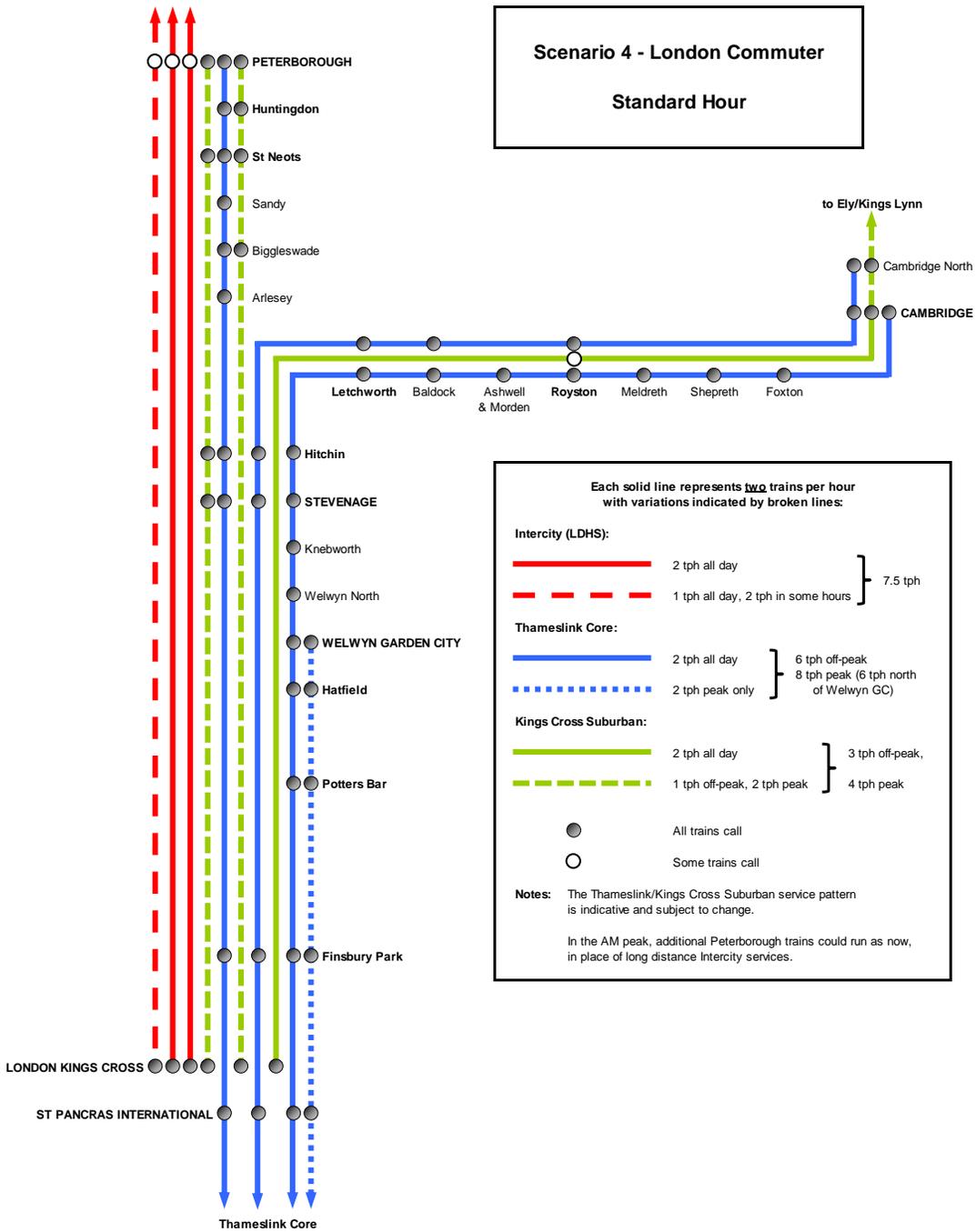
Each solid line represents one train per hour

- Hourly service
- Hourly calls

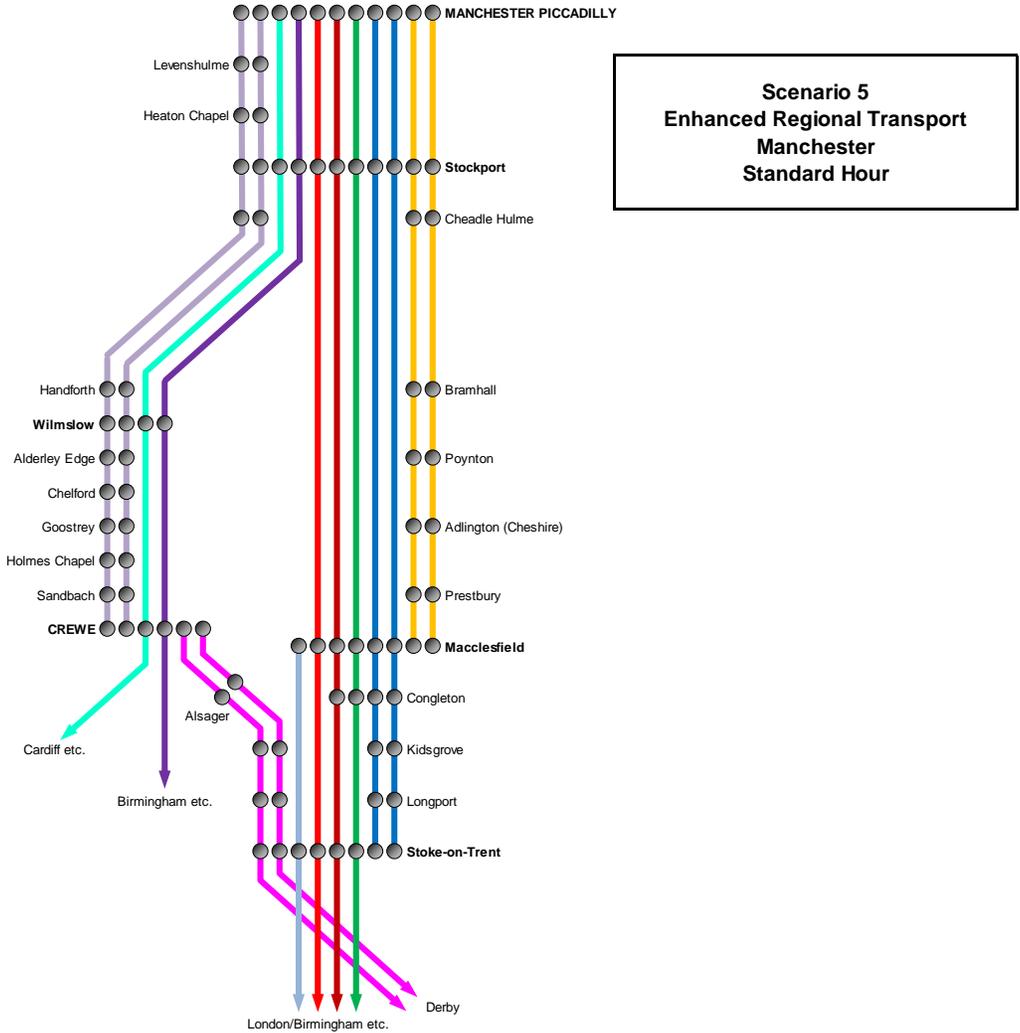
Scenario 2 ECML New London Destinations



Scenario 4 ECML London Commuter



Scenario 5 Enhanced Regional/Local Services Manchester Piccadilly



Scenario 5 Enhanced Regional/Local Services - Doncaster to Leeds Corridor

