Towards a High Speed **Network**.

Summary

This article argues the necessity of developing an overall network plan for all the HS routes that will eventually be needed.

It demonstrates that HS2 has been planned completely ad hoc and in isolation, without any consideration of how it should relate to other HS routes or to the existing classic network. As a direct consequence of this lack of context, certain aspects of the plans are profoundly mistaken and would be very damaging in their consequences. The article, although strongly in favour of HS rail, argues that if HS2 is implemented according to the current plans, the result will be a disaster.

It then suggests how these faults may be remedied, and describes, at high level, the resulting overall network, pointing to other, supporting articles, which contain detailed plans of the individual routes and their services.

It finally describes the provision for HS in London, and shows how all the various routes serving London can be accommodated by just two cross-London, inter-regional, HS connections, enabling through services of hitherto unimagined quality and convenience.

Appendices give details of variable platforms, provision for passenger numbers in London, and the ideal order of implementation of the total network.

Contents *Page*

The General Argument

HS2 is the most significant UK infrastructure project for several generations. Its importance for the UK's future prosperity, of which the transport system is the foundation on which everything else is built and relies, can scarcely be overstated. HS2 is, however, no matter how important, just a first step.

I see very little discussion of the overall shape that the future high speed network should take, or even whether there should **be** a high speed network. But no-one is suggesting, either, that HS2 is all that's needed; the matter is simply not being addressed. I urge that we do need, seriously, to consider this matter, and develop a long-term plan. This needn't, as yet, be in very great detail, but it would form a framework in which the relationship of the various projects to each other could readily be seen, and, in particular, the interdependencies. Otherwise we could easily find that decisions taken and implemented at an early stage conflict with the then unforeseen requirements of a later stage, in extreme cases foreclosing on the latter. The existing HS2 proposals contain several clear and serious examples of this. It is always easier and usually far less costly to make (possibly just passive) provision at an early stage for later requirements.

I argue that HS2 is being seen and planned as an isolated, completely self-contained project, (rather than as several components of a network,) and that the most serious faults of the HS2 plans arise **precisely** because of this. Specifically:

- the ridiculous 'Y' shape, which takes no account whatever of capacity;
- the lack of any connection with HS1 (the original plans contained a grossly inadequate, single-track connection; this inadequacy was subsequently recognised with the publication of the HS2 Plus report, and withdrawn pending reconsideration, but with the latest plans, the proposal has simply been omitted altogether, as evidently 'too difficult');
- the appalling proposals for parkway stations for the East Midlands and South Yorkshire;
- the disastrously short-sighted plans for terminal stations in Manchester and Leeds;
- the catastrophic proposals for redeveloping Euston as a terminus;
- the serious degradation in service proposed for locations on the associated classic route which are not served by HS2 (most infamously Stoke-on-Trent);
- the lack of any proposals to increase GC-gauge route.

Note that I am not claiming that the HS2 team is at fault here. HS2 Ltd. is not, as one might suppose, an independent consulting organisation which won the contract to develop the HS2 plans, but 'a non-governmental public body, wholly owned by the DfT'. They 'carry out activities in line with the remit set by the Secretary of State for Transport', working to a particular brief with, clearly, far too many features already prescribed by the politicians, and have fulfilled that brief very professionally. HS2 Ltd. is not paid to criticise the DfT's requirements, nor to come up with original ideas, but to pay close attention to its master's voice and come up with plans which implement those (heavily over-prescribed) requirements.

Originally I argued, magnanimously, that **no-one** was at fault (at least, not yet), and that the problems came from a mistakenly restricted outlook, as if HS2 were all we would ever need to do to solve our transport problems and needs. I further argued that this was not the case, and so we need to widen our vision to consider the entire HS network that we will eventually need, and how that impacts on the work we are doing now. But as the DfT shows itself obstinately impervious to (even friendly and helpful) criticism, and pig-headedly ploughs on with its mistaken and misbegotten proposals, the time for magnanimity has come to an end; the 'not yet' has become 'now'.

I wish to sound a very serious warning, above all the rest, of the impending catastrophe of the current proposals for Euston. In the context of HS2, alone and free-standing, the proposals may seem, if not the best that could be done, at least an adequate and functional solution. It is only when considering the overall network that their outright lunacy becomes plain. They throw away the opportunity of the century to achieve a quantum leap in the extent and quality of inter-regional connectivity in the South East.

These are harsh words, and I shall have further hard things to say. But I must stress that I am a fervent supporter of high speed railways, and it grieves me to have to make these criticisms. Indeed, I regard the existing proposals, apart from these few particular (but very serious) aspects, as fundamentally sound, even excellent. But these faults, although few, are so serious as to wreck everything else, and vitiate all the otherwise good work.

[Appendix A gives the background to this article, and lists and describes all the associated, supporting articles. Originally this appeared in the main text, but I believe the flow of the argument is improved by relocating it to an appendix.]

Existing Plans for UK High Speed Rail, and Some Misconceptions

It is a fundamental design principle of UK High Speed lines that they are built to the European Standard GC loading gauge. The decision to go for this high quality standard is very commendable, and most unlike the usual myopic short-termism that has generally characterised British planning or (more often) lack of it. This admirable decision, that for all new-build trunk lines we will go for the best of current practice, deserves to be celebrated.

A most important consequence follows. Two types of train will run on HS lines, captive trains, built to take full advantage of the GC standard, and classic-compatible trains, built to British standard loading gauge. The GC-gauge, captive trains will run only on GC-gauge lines, but the classic-compatibles will, in principle, run anywhere in the UK (on electrified lines, of course). On HS lines, there should be no difference in speed between them, but on classic lines, the classic-compatibles will obviously travel at significantly lower speeds.

The inability of GC-gauge trains to run on UK-gauge infrastructure has two aspects. Firstly, and more seriously, the trains themselves would foul tunnels, overbridges and lineside structures. It would also, very likely, prove impossible to run two tracks over existing underbridges and viaducts – the tracks have to be further apart to keep the kinetic gauges (i.e. the maximum cross-sectional size of the vehicles – the actual loading gauge – plus an aerodynamic safety margin around the edges,) distinct and non-intersecting. It is thus clear that widening an existing line to GC gauge could be a very serious piece of work, only to be contemplated in special and very pressing circumstances. (A possible exception is for lines in flat, sparsely populated regions, such as parts of East Anglia and Lincolnshire, where there are very few over- or under-bridges, and almost no tunnels. Here the work would consist merely of slewing one track to the side, and building new overbridges to replace all those level crossings! A bit more work would be necessary at stations, of course.)

The second aspect is that GC-gauge trains would foul UK-gauge platforms, since GC-gauge platforms are lower (by about 6”,) and further from the track centre line (by about 8”). It is therefore often stated that if GC-gauge and UK-gauge trains were to serve the same station, they would need separate platforms. This

is not in fact the case. They could readily use the same platform, provided it were variable. This could be effected in many ways. Appendix B explains a particularly simple and robust way of doing it.

There is a widespread belief that HS lines can have virtually no intermediate stations, and that to stop trains at intermediate locations would completely wreck performance. This is a total misperception. If designed correctly, a HS line can have (within reason*) any number of intermediate stations, without detracting from its performance. Very briefly, this is achieved by providing (very) long stopping loops at stations. A stopping train diverges from the main line at full line speed (this calls for very high grade point work, of course) and has ample distance to decelerate on the stopping loop before reaching the station platform. Similarly it has ample distance to accelerate back up to line speed before rejoining the main line. Services not stopping at that station simply pass through, unobstructed. Stopping services do not obstruct non-stop ones simply because they get out of their way in a timely fashion. (This is the defining characteristic of a **same-speed** railway, of which high speed is a special case.) Exactly the same considerations apply to a low-speed railway – this sounds amusing at first, but a high capacity dedicated freight line could advantageously be operated in this way. I deal in detail with **Same-Speed Railways** in an article with that title – refer to appendix A for all such supporting articles. This behaviour is **exactly** analogous to motorway driving: vehicles do not slow down on the motorway before diverging at a junction; they travel at full speed onto the slip road, and slow down there. Likewise they accelerate to full traffic speed before joining the motorway. 'Slip-lines' are, of course, very much longer than slip-roads. If there are several intermediate stations, then stopping a particular train at all of them, even on a HS line, will seriously reduce the average speed **of that train** for the overall end-to-end journey, and this is where, presumably, the confusion arises. But it will have no impact at all on other, non-stopping services. In fact, given the overtaking provision at stations, as described above, non-stop and stopping services can coexist entirely successfully on a HS line; on the main line they all travel at the same speed. (Again, this is a characteristic of all same-speed railways; the actual speed is irrelevant.)

The above explanation is valid in its essentials, and good enough for a high-level understanding, but it **is** very much simplified. Technology junkies are referred to appendix B of the 'Same Speed Railways' article, which contains the full story, and references to the original source articles, for those who **must** have the really hard stuff. (The methods contained in that appendix also enable the estimation of overall journey times, which is immensely valuable.) The true situation is considerably more complicated and more subtle. However, it is worth pointing out that the statement 'stopping services do not obstruct non-stop ones simply because they get out of their way in a timely fashion' is, if the line is designed correctly, literally true! Refer to the 'Same Speed Railways' article, specifically the section entitled 'The Effect of Junctions – Revisited' for the explanation of how this is ensured. (* 'Within reason' indeed. Bear in mind that stopping a train to serve an intermediate station imposes a time penalty **on that train** of the order of 7 minutes. Clearly it wouldn't take very many stops to bring the average speed **of that train** right down to classic levels.)

Whenever the need for additional passenger capacity is discussed, sooner or later someone will come up with the idea of double-decker trains. (They usually seem to think that nobody has thought of it before.) On the UK loading gauge this is a complete non-starter. It's been tried; we're (most of us, anyway) just too big for them, and also loading/unloading take too long. But GC-gauge easily accommodates double-deckers, with plenty of room inside them. Provided there are no serious technical problems in running double-deckers at full High Speed (360kph, 225mph), and also that the travelling public likes them, I would urge that **all** GC-gauge trains should be double deck. These are often thought of as suitable only for suburban services, and indeed they are superb for that. But the Swiss run double-decker inter-city expresses, and very fine and comfortable they are. I would like to suggest borrowing a Swiss double-

decker inter-city and running it on HS1 for a few weeks, to give people a taste of what GC-gauge travel could be like. (The Eurostars are of course built to UK loading gauge, though for GC-gauge platforms.)

That's a lovely idea, but of course the Swiss trains are the wrong voltage for us (wrong frequency too). We'd have to buy one from them, and convert it. But I still think it worth doing.

As a rule of thumb, a double deck train offers the same passenger capacity in two-thirds the length of the equivalent single-decker, thus 4 carriages equates to 6, 8 to 12 and 12 to 18. Put another way, a single-decker has to be half as long again, to provide the same capacity. This offers very serious savings in platform length and thus station area.

Some people think it's crazy to have trains that can travel on only a small portion of the network. Other things being equal, this argument has some merit. But other things are not equal. The increase in capacity offered by GC-gauge rolling stock, as compared with classic-compatible, is profound. I also think the above a defeatist attitude, which accepts the cripplingly-restricted UK loading gauges for ever. With GC gauge for all new High Speed lines, we have an important and growing portion of the network able to accommodate the larger standard trains.

That last point is critical. The benefits of GC gauge will be fully realised only if it does indeed increase over time as a proportion of the total network. I suggest that the long-term strategy should be that **all** the network be GC gauge. I appreciate that this is unlikely ever to be achieved completely, not even in the long run (when, of course, we're all dead, anyway). But this should be the fundamental, informing principle of policy, thus requiring explicit justification for any new piece of infrastructure not of GC gauge. In particular, we need to start giving serious thought to the complete High Speed (thus GC-gauge) network that the country will eventually need.

Having said all that, the existing plans show no intention whatever of increasing the amount of route built to GC-gauge, beyond the initial segments to Birmingham, Manchester and Leeds. All services extending beyond that initial core are envisaged as classic compatible. Even the presently hazy proposals for transpennine ('Northern Powerhouse') services are inevitably CC, since there are no proposals to correct the New Lane station plans, to be able to accommodate through GC-gauge services (see the discussion of the 'Yorkshire Hub' report on pages 10/11). If that really is the case, then there is absolutely no point in adopting GC gauge for such a tiny portion of the complete network, and the defeatists condemned above do actually (I regret to concede) have a valid argument.

The Need for an Overall HS Network Plan

The purposes of planning, for any large project of any type, include the following:

- to delineate the purpose of the project, stating precisely why we're doing it and what it aims to achieve, so we can judge, if it goes ahead, whether it actually achieves its purpose and, if not, why not
- to get a sense of the scope of the project, of its overall magnitude, and a high level view of its contents
- to get a first estimate of costs and of benefits and thus the BCR
- to break the project down into more manageable subprojects, to as many levels as necessary, so that the end planning units are readily intelligible, implementable and manageable

- to ascertain the linkages, interfaces and dependencies between the various subprojects
- to evaluate the priorities and relative importance of the various subprojects
- to derive an optimum order of implementation, on the basis of priorities and dependencies

The above planning aspects are not in any particular order, though it is probably sensible to decide **why** we're (considering) doing it, before deciding anything else, i.e. what are its drivers?

For infrastructure projects, such as HS rail, it is essential to identify the land-use requirements, and incorporate these in all the various local and regional plans, in order to safeguard the alignments and specific locations, such as proposed station sites, and ensure that its requirements do not become accidentally (or even deliberately) compromised or obstructed by incompatible developments.

I believe that the UK urgently needs an overall network plan for HS rail. For present purposes, a single level of granularity, the individual routes, is sufficient. At present, nobody seems to be giving any thought to this matter, or, if they are, they haven't bothered to publish their thoughts. HS2 seems to be as far ahead as anyone cares to look. But then the 'One North' report appears, and suddenly everybody is speculating (on remarkably little hard data) about 'HS3' (which irks me, as I'd already assigned that number to a quite different project – HS8 and HS9 are my transpennine proposals).

The **conceptual** problem with this incremental, ad hoc approach, is that it completely lacks any sense of how each individual piece fits into an overall pattern (there being no perceived overall pattern). There is thus no recognition of linkages, interfaces and dependencies. As a consequence, there is no sense of the relative importance of the individual components, nor of the optimum order of their implementation. The **practical** problem with all this is that decisions taken now without any sense of future requirements may easily conflict with those presently unforeseen requirements, (but definitely foreseeable, if we only took the trouble,) making them more difficult or even, in extreme cases, impossible to achieve.

Planning is cheap. Rectifying mistakes consequent on a lack of planning is expensive, often prohibitively so.

The HS2 Plans

HS2 has been planned in isolation. It thus recognises no other HS routes (or classic ones!) As a direct consequence, it tries to do too much, and, unsurprisingly, ends up doing it badly.

'It is no secret now that the first plan for HS2 was an emergency response to economic crisis' ('Guardian' editorial, Sunday 16th March 2014). This, now evidently conventional, wisdom seems to originate in an article by Peter Mandelson in the 'Financial Times' at the beginning of July 2013, saying amongst other things that Labour's backing for the project in 2010 was a 'politically-driven' decision intended to 'paint an upbeat view of the future' following the financial crash, and admitting that the original cost estimates were 'almost entirely speculative'. (It seemed not to occur to him that this evident cynicism in any way reflected adversely on the reputation of that government of which he was a member, or on himself.)

The apparent origin of the scheme in base political calculation does not necessarily detract from its worth, since a lot of excellent work has been done since then, by highly competent and committed people, to develop the plans to their current state, which is very valuable and worthwhile, although disastrously serious problems remain. However, if its origin really was essentially a political wheeze, that may explain certain otherwise surprising characteristics.

It must have seemed a brilliant idea to the politicians to design it in a 'Y' shape, so that it would serve both Manchester and Leeds, as well as Birmingham, thus spreading the benefits as widely as possible, and maximising popular support. This idea has become so ingrained in the public's perception of the project, that it feels positively heretical to assert that, on the contrary, it is a very bad idea indeed, since it takes no account of available capacity, and the result would be that the core section to Birmingham was fully loaded, while not providing a particularly good service to either Manchester or Leeds, and with no scope whatever for further expansion. The article 'HS2 and Classic Service Plans' analyses HS2 Ltd.'s published plans in this area, and, inter alia, gives the figures on which the above statement is based. (I seem to remember, years ago, when the first serious proposals for HS lines were being discussed, that the idea was to have a 4-track trunk to Birmingham. That would indeed have provided the necessary capacity, but the idea somehow got lost along the way.)

As well as the capacity constraints explained above, travelling to West Yorkshire via Birmingham imposes (unsurprisingly) a serious time penalty, compared with what a sensibly-designed, direct HS route would offer. Until very recently, this was merely an unquantified suspicion, but now that journey times can be estimated, it is clear that, on HS2 Ltd.'s own published figures, it takes 20 minutes longer to travel to South Yorkshire or Leeds via Birmingham as compared with a direct route through the East Midlands, and 30 minutes longer to the centre of Sheffield (to Sheffield Midland, adjacent which is where the HS station would be located). The eastern arm of the 'Y' configuration is thus not merely a bad idea, but also a stupid one.

It would also, I think, appeal to the political mind (which loves a 'silver bullet') to see the HS railway as a stand-alone system, untainted by the failings of the 'classic' railway, a one-time fix to solve all the problems. It is certainly noticeable how little attention the published plans give to interfacing with classic services, and I read the astonishing statement by Andrew McNaughton, technical director of HS2 Ltd., in a recent interview that 'when HS2 opens you've got a chance to throw away the past'. The gentleman is clearly no historian, or he would shrink from expressing a sentiment with such malign associations, Maximilien Robespierre and Pol Pot to the fore. (He might just as unfortunately have referred to it as a final solution to the problems.) Even Sir David Higgins, in the generally disappointing 'Rebalancing Britain' report, (long on aspiration, short on detail,) subscribes to the 'silver bullet', describing HS2 as 'a new spine for the national rail network'. In my opinion, that is absolutely wrong. HS2 is not a 'new spine', supporting all the rest, but one new line among what should be many, all of which, together with all the classic routes, comprise the total railway network, an organic, integrated whole, **all** the parts of which are necessary and important. (I find it mordantly amusing the way 'Rebalancing Britain' considers east-west and north-south connectivity, the North West, East Midlands and South Yorkshire hubs, and so on and so on, and concludes that the existing proposals are exactly what is required to solve them all. Perhaps it offers a cure for piles, too?)

Likewise political, is focusing on the big outcomes, and ignoring the detail. Thus services to Birmingham, Manchester and Leeds, but little thought about the locations in between. There is, as noted earlier, a widespread belief that HS lines should have virtually no intermediate stations, and that to stop trains at intermediate locations would completely wreck performance. This is simply untrue, for reasons already explained.

The above features, surprisingly and quite unnecessarily deleterious to the outcome, become intelligible once it is realised that the design was developed to implementation parameters set by the politicians, rather than by what would be ideal, working from first principles but considering the existing system as it actually is.

By trying to do too much, HS2 ends up not doing enough. The first step towards a solution is to scrap the 'Y' configuration, and refocus HS2 as the route to the West Midlands and North West. Manchester and the North West can then be given a decent service, with plenty of classic-compatible services too, so that places off the HS route, like Stoke on Trent, don't lose out. Refer to the HS2 Route and Service Plans article, for full details.

The Leeds arm of the 'Y' doesn't disappear, but becomes part of other routes, HS7 and HS3 specifically. It always did appear to be an afterthought, less well planned than the route to Manchester. In particular, the parkway stations proposed at Toton and Meadowhall were a very poor strategy. They represent an engineering solution (locating the stations where it's most convenient to build them) rather than a business solution (offering potential passengers what they actually want and will buy). If these wretched proposals are actually implemented, I predict that the two stations will see massively less use than their promoters confidently expect. But it's little comfort being proved right after the event, when the damage has irreversibly been done.

Attempting to serve cities by parkway stations, miles from the city centre, is a **profoundly** bad idea, for several reasons, but their gross inconvenience will do for now. (This deserves a lengthy article in its own right, which I intend to give it, but not here.) There is a (niche) market for parkway stations, where an area contains a sizeable population, within easy driving distance, but diffusely spread, so there is no centre of population to serve directly.

It is of course impossible to serve both Derby and Nottingham equally well on a N-S axis, though it is certainly possible to serve them both equally badly, as Toton would. Instead, it is proposed that they be served by separate, city-centre stations, Nottingham on HS3 and Derby on HS7. The main line of HS3 actually joins and takes over the proposed HS2 route at Toton, and HS7 joins it a little to the north at Nuthall North Junction, but the Nottingham station is on a loop. The proposed HS2 alignment through Nottinghamshire is thoroughly excellent, and I see no need to change it. See the HS3 and HS7 Route and Service Plans articles for full details.

The situation in South Yorkshire is more difficult, in two ways:

1. Given the proposed HS2 alignment, it is in fact impracticable (impossible, except at really vast expense,) to serve the centre of Sheffield by services which then, without reversal, proceed on to Leeds/York. (There's nothing new about this; Sheffield simply isn't on the natural route from the East Midlands to the north via the Erewash and Rother valleys, and the present proposals are merely repeating Sheffield's experience in the first railway age.)
2. The proposed Meadowhall location is in fact popular with Barnsley, Rotherham and just about everyone else in South Yorkshire outside Sheffield. Whereas the East Midlands is bipolar (tripolar, of course, but Leicester doesn't feature in the present context), South Yorkshire is polycentric, and there is a clear conflict of interest between the dominant centre, Sheffield, and all the rest.

Andrew McNaughton is on record as stating that Sheffield by itself would support just one HS train per hour. My suggested solution is that Sheffield centre get its 1HStph, via a connection between HS3/HS7 and the Sheffield – Retford line in the Beighton/Woodhouse area. This would serve Sheffield Midland station, originating/ terminating there, and would of course have to be a classic-compatible train, but there shouldn't be any problem accommodating it. All the trains to Leeds/York would travel via Meadowhall, as planned. This solution has the virtue of letting the market choose. (Most Sheffielders would probably say they didn't want to go to Leeds anyway.)

My proposal for a classic-compatible service from London to Sheffield Midland has two aims:

1. To satisfy the legitimate aspirations of Sheffield for a high speed service to a central station in a cost-effective manner without in any way compromising the benefits of the current plans for the **rest** of South Yorkshire
2. Keeping alive the idea of a proper, central, dedicated HS station, by implementing the first step towards it – the junction with HS3 at Beighton.

I believe there is a valid and necessary role for a Sheffield HS city-centre station, but that it is in the longer term (precisely the sort of reason we need to think in terms of an overall network plan). But see also the note at the end of appendix D.

The station should be located behind and above the existing Midland station – there is **plenty** of room there for it – and **not** at the former Victoria, which is and always was a rotten, inconvenient location. Depending on precisely where it is located, a greater or lesser amount of excavation of Park Hill would be required, with a greater or lesser magnitude of retaining wall. The Supertram routes to Halfway and Herdings pass directly through this location, and would need some realignment, and that to Meadowhall and, soon, tramtrain to Rotherham, is only a short distance away. The Pond St. bus station is right next door. So we have a city centre HS station, as big as we need to make it as there's plenty of room, adjacent to (functionally part of) the existing station, with tram or bus connections to all parts of the city, and just a few minutes (very agreeable) walk from the actual city centre. What's not to like?

HS2 Ltd. actually considered this location, only to reject it. They had, I imagine, already committed themselves to Meadowhall, and only considered the Midland for form's sake (and just in case a central station at Sheffield became a political imperative, in which case, that's where it would be).

The long-term HS solution for Sheffield is as a key interchange point on the HS Southern Transpennine route (HS8). The HS3 and HS Transpennine Route and Service Plans articles contain full details.

The HS2 proposals for the Leeds New Lane station are a striking example of ignoring future requirements, and thereby making them more difficult, even impossible, to satisfy. This is proposed as a terminal station, on viaduct, orientated in a north-westerly direction, pointing straight at City station. The approach is from Hunslet. While there could well be services from London that terminate at Leeds, this configuration is completely unsuitable, and indeed absolutely precludes its use, for transpennine services. (A transpennine service terminating at Leeds is a complete nonsense.) Leeds New Lane is a perfectly good, even an ideal location for the new HS station (since there's absolutely no room for it at the existing City station). But it needs to be rotated through 90° so that it is pointing towards York, for later extension for transpennine services, and this will need a completely different approach. Such an approach is in fact readily available, via the currently disused viaduct line from Wortley (Gelderd Road) Junction. (In my opinion, this proves conclusively that HS2 has been planned in complete isolation from the rest of the network, with little or no thought for how it should be developed in the future.)

Interestingly, HS2 Ltd. has just published a new report, 'The Yorkshire Hub', which considers possible enhancements to the New Lane proposals. However, the only point it considers is integration with Leeds City station, ideally with a common concourse. To this end it recommends shifting New Lane station northwards, extending over the river, actually to abut on City station. I regard this as a total waste of money and effort, and of course it completely misses the point of what is really wrong with New Lane, that it is pointing in the wrong direction. Integration with City station would best be achieved by an elevated, fully enclosed footbridge, (but with continuous windows along both sides, lest it seem

claustrophobic,) connecting New Lane and City on the level, (or on a gentle slope, if a difference in level must be accommodated,) including travelators for the entire distance between them. The two stations would form one concourse, with passengers able to enter at the existing City entrance, or at the new south side entrance, or at New Lane, and move freely through the entire area, unobstructed by any further barriers or (unavoidable) steps. This option simply does not appear in the report, not even to be considered and rejected. (I believe it would completely cancel the advantages of the chosen option.) The second option considered is the existing New Lane proposal, which now envisages a 10 minute walk through the streets, in the rain, and carrying luggage, for any passengers unfortunate enough to have to switch between stations. (It's very strange that this was never pointed out previously!). This is simply unbelievable, and is just rigging the argument. The third option considered is clearly a 'straw man', there just to make the numbers up. It considers extra platforms actually adjacent and parallel to City station, on the south east side, and approached from the east (i.e. from the Marsh Lane direction). This would involve a new viaduct through a built-up area, right past Leeds Minster. (My proposals go nowhere near Leeds Minster!) This is clearly not a serious proposal – it wouldn't even make available the required number of platforms, there being simply insufficient room for them (which fact was known well in advance, and caused the New Lane site to be chosen in the first place). It is, however, interesting, in indicating future expansion potential for the classic route.

All three options envisage 'Northern Powerhouse' services (i.e. transpennine) switching from HS2 to the classic route on the approach to Leeds, and passing through City station (in the case of the approach from the east, this would involve a reversal at City). This necessarily implies they would all be classic compatible, and indefinitely so, since there is no way that any of the options could ever accommodate GC gauge transpennine services. This presumably further implies that any HS transpennine route would only be of UK loading gauge, since what could possibly be the point of building it to the proper HS GC gauge, if GC gauge trains could never use it, or, at any rate, not beyond Leeds? I consider that these proposals have simply not been properly thought through.

As noted earlier, if there really is no intention to extend the GC-gauge routes, there is no point in adopting GC-gauge in the first place. These proposals really have not been properly thought through.

Broadly similar remarks apply to the HS2 proposals for the Manchester HS station. This is proposed as a terminal station, on the north side of and adjacent to Piccadilly station. This is certainly an excellent location, and there certainly will be services from London which terminate there. But it is also required for transpennine services, and must therefore be a through station (as with Leeds, transpennine services terminating in Manchester are a complete nonsense). It is, unlike the Leeds proposal, already suitably orientated for the transpennine services, but far too high. The transpennine services need to gain tunnel as quickly as possible on leaving the station, to get under the Rochdale canal, and across – underneath – central Manchester, so the station needs to be at a considerably lower level than that proposed. Considering HS2 as part of an overall network, this requirement, that the Manchester station needs to be lower, is recognised in advance, and it is no great problem to build it lower, and the result is thus, from the start, also suitable for transpennine services. Considering HS2 in isolation, the resulting terminal station is completely useless for transpennine services, so separate provision would have to be made for them, and the HS terminal station would be in the way of this.

Bad as these two examples are, they pale into insignificance in comparison with the impending catastrophe of Euston. I think 'catastrophe' not too strong a word for the expenditure of a vast quantity of money and the imposition of a vast amount of environmental damage on Camden, huge public inconvenience over a long period and the serious hypothetical cost of consequent major benefits foregone,

to produce a markedly inferior, thoroughly second-rate outcome, as compared with what could be achieved for a comparable monetary outlay, minor damage, minimal public inconvenience and those consequent major benefits achieved. There is also an even more fundamental danger, which I shall explain later.

In planning the provision of passenger facilities for high speed trains in London, there are only two possible options, either to rebuild and extend an existing terminal station to accommodate GC-gauge trains, or build a new station for them. There is no escaping this choice; GC-gauge trains simply cannot use existing UK-gauge infrastructure. All the London termini are already fully loaded with their existing services; there is no spare capacity available anywhere. Many people have suggested building a new terminal station in a peripheral location, at Old Oak Common. As a **permanent** solution this is a very bad idea. It would have all the disadvantages of a terminal – everybody has to change – at a location where nobody actually wants to be, and would oblige all passengers to continue to their destination via metro services. However it does have serious advantages as a **temporary** solution, allowing GC-gauge services to run before the permanent provision for them is ready. It should be a terminus only for GC-gauge services, with a continuation to connect with the existing line into Euston, for classic-compatible services. This proposal is dealt with in detail, in the article 'Crossrail Service Plans'.

Terminal stations in areas of high traffic demand are in any case a **profoundly** bad idea; trains arriving at a terminus, emptying, being serviced in situ, then refilling and forming a service in the reverse direction, make prolonged demands on platform capacity.

The HS2 plans for Euston envisage 11 completely new terminal platforms, almost doubling the size of the station and thus the area it occupies – its 'footprint' – requiring extensive demolition of surrounding properties. Each of these new platforms would serve precisely two trains per hour, each taking 20 minutes to arrive, empty, be serviced, reload and depart (plus 10 minutes contingency). This is simply crazy. A through platform, with the latest signalling and train control, could handle up to ten times as many. And such a proposal, that of the 'Railway Lords' for Euston Cross, is already on the table.

I have seen the HS2 proposals for the redevelopment of Euston described as 'a 19th century solution to a 21st century requirement'. This has a certain wit, but is, I think, a gross libel on the Victorians. The only reason, I suggest, that the original railway companies built terminal stations in London is that London is as far as they went – their business was to link London with some other part of the country, and they had no requirement to go beyond London. In cases where their interests did extend through and beyond a major city / metropolis, they were fully aware of the need for, and perfectly capable of developing capacious and well designed through stations, in excellent central locations, as witness Birmingham New St. and Edinburgh Waverley.

The article 'HS2 and Classic Service Plans' analyses HS2 Ltd.'s published plans for services on HS2 and associated classic routes at phase 1 and phase 2. It highlights the severe degradation of service planned for the classic routes. It is surely self-evidently true, that no location should suffer a worse service as a consequence of a HS line opening. Yet many places, most infamously Stoke-on-Trent, will suffer a very much worse service when HS2 phase 2 opens, according to current plans.

The problem arises because express services on a classic trunk route between a major regional centre and London, (Manchester – Euston in the present case,) typically have a number of stops at the regional end, to pick up traffic from lesser but still important locations in the originating region (the 'secondaries', say – in the present example Stockport, Macclesfield and Stoke-on-Trent), then a long non-stop (or just one or two stops) run to London. The bulk of the traffic is from the first station (Manchester Piccadilly). A HS

line links the endpoints of the associated classic route, and would reasonably be expected to take over all the end-to-end traffic from the classic route. It may also serve other intermediate locations, but will not directly serve the secondaries, which thus could face a worse service than previously. The way to solve this dilemma is to run a classic-compatible service along the initial section of the classic route, serving all the secondaries (and ideally a few more secondary-type locations, to help fill it), and then to leave the classic route and join the HS route at an intermediate junction. In the present example, my proposal is to run a classic-compatible service Manchester Piccadilly – Stockport – Macclesfield – Stoke-on-Trent – Stone – Stafford – Rugeley Trent Valley (for Walsall and Cannock) – <Handsacre junction> – Birmingham Interchange – Calvert – Old Oak Common – Euston. This also has the serious advantage of freeing up slots on the classic route (over the entire section beyond the intermediate junction with the HS route, but most importantly on the approach to London, where capacity is under most pressure). If the traffic is no longer sufficient to fill the classic-compatible train adequately, use a shorter formation.

This solution is simply not possible under the current plans, with the 'Y' configuration, since there is absolutely no capacity available for it on the core section between Birmingham and London. Scrapping (i.e. making provision elsewhere, on other HS routes) the eastern arm of the 'Y' allows for an extra 6tph to Manchester and the North West, two of which are very beneficially assigned to the above service.

The Network Solution for London's HS Provision

My own planning indicates that London requires and justifies the services of seven high speed routes:

- HS1 (existing route plus short extensions) Kent and East Sussex (Maidstone, Ashford, Dover, Hastings), also to Europe
- HS2 West Midlands and North West (Birmingham, Manchester, Liverpool, Preston)
- HS3 East Midlands, Yorkshire, North East and Scotland (Northampton, Leicester, Nottingham, Sheffield, Leeds, York, Newcastle, Edinburgh, Glasgow)
- HS4 South Wales and (in conjunction with HS7) the West Country (Cardiff, Swansea, Bristol, Exeter, Plymouth)
- HS5 Sussex, West Kent and Hampshire (Brighton, Eastbourne, Newhaven, Tunbridge Wells, Chichester, Portsmouth, Southampton)
- HS6 West Anglia and (in conjunction with HS8 and HS10) Lincolnshire (Cambridge, Ely, King's Lynn, Norwich, Peterborough, Lincoln, Hull)
- HS11 Essex, North Kent and (in conjunction with HS12) East Anglia (Southend, Faversham, Canterbury, Dover, Chelmsford, Colchester, Ipswich, Norwich).

For all these routes, there are **no** GC-gauge services which start/terminate in London itself (except for the very special case of HS1's European services which do indeed start from and terminate at St. Pancras International). Each route instead leads to a new, underground, GC-gauge, through station, where it links with another route serving the opposite side of London, and all services pass between them.

In fact, only two such stations are required, for the entire seven high speed routes:

- Euston Cross, served by routes HS2, which connects with the (non-European) services of HS1, and HS4, which connects with HS11/HS12
- Pancras Cross, served by routes HS3 and HS6/HS10, which connect with HS5.

In both cases, a single pair of approach tunnels and 6 platform faces (ideally with passive provision for 8) are sufficient to accommodate all the services required at the ultimate maximum frequencies, as far ahead as the associated plans reach, around 50 years into the future. (But see also Appendix C concerning passenger volumes).

In all cases but HS5, the above HS routes have some services which must remain classic-compatible indefinitely, since they serve locations off the new, HS sections, for which there is no conceivable justification in the foreseeable future for widening to GC gauge. (All the locations mentioned in the list of HS routes, above, are served by GC-gauge services.) These classic-compatible services all start/terminate at the appropriate classic terminal station, specifically:

- HS1 – St. Pancras East (the 'Javelin' platforms); HS1 in fact has only 1 classic-compatible service
- HS2 – Euston (4 services)
- HS3 – St. Pancras West (the Midland platforms – 4 services)
- HS4 – Paddington (4 services)
- HS5 – this has no classic-compatible services
- HS6/HS10 – St. Pancras East (3 services)
- HS11/HS12 – Liverpool Street (6 services).

As already stated, the GC-gauge services would need new or extensively rebuilt stations in any case, since they simply cannot use existing stations of UK loading gauge. Consequently the choice is between adapting the existing stations, all of which are terminals, or of building new ones, GC-gauge from their inception, which could and should be through stations.

Building new would certainly be very much less expensive overall than rebuilding and enlarging **all** the relevant classic terminals, above, (and their approaches!) and involve minimal environmental damage and very much less disruption. But even more importantly for the passengers, it would enable truly superb cross-London inter-regional, high speed services, which is a completely new concept. These are:

- West Midlands / North West (HS2) – Euston Cross – Kent / East Sussex (HS1)
- South Wales / West Country (HS4/HS7) – Euston Cross –North Kent / East Anglia (HS11/HS12)
- Scotland / North East / Yorkshire / East Midlands (HS3) and West Anglia / Lincolnshire (HS6/HS10) – Pancras Cross – Sussex / West Kent / South Hampshire (HS5).

Many passengers at present choose deliberately to select a slower service in order to avoid a change of train. This is perfectly sensible: changing trains, encumbered with luggage, is a major drag. If the journey crosses London, there is at present unlikely to be the option of a through service, however slow, and a minimum of two changes is generally necessary, which is no fun.

This vision becomes clear and compelling when one considers the complete HS network which we will eventually need. If one is considering only HS2 in isolation, and only in the shortest term, then it may seem an extravagant proposal. This was indeed the reaction of many commentators to the original proposal of the 'Railway Lords' for Euston Cross – which is clearly acknowledged as its inspiration. That proposal, as I understand it, was originally developed as an alternative to the dreadfully inadequate plan for a 1-track connection between HS2 and HS1 for European traffic originating from beyond London. (The inadequacy of that plan was subsequently recognised and it has now simply been scrapped.) But it quickly became apparent, and research has subsequently confirmed, that demand for inter-regional travel across London far exceeds the demand for regional international services. I personally don't think

regional international services a good idea at all. Euston Cross would enable excellent interchange facilities with St. Pancras International, which already has all the necessary border and customs controls. It would be different if the UK were a signatory to the Schengen agreement, but it isn't, and I don't think it likely that it will be in the foreseeable future, indeed its membership of the EU itself may be in doubt.

Let me make myself entirely clear: the justification for the cross-London GC-gauge interconnections is economic. This is a **much less expensive** way of providing the GC-gauge infrastructure, which is unavoidably required, than the only possible alternative, of redeveloping and effectively doubling the size of **all** the relevant terminals, and their approaches. Consider: in developing Euston Cross, linking HS2 with HS1, we have already provided for HS4 and HS11/HS12 also (which would, on the other approach, require the redevelopment of Paddington and Liverpool St. respectively). The extra costs are trivial – a connection to the GWML at Old Oak Common and to the GEML at Manor Park. We thus have the truly astonishing situation where the very much less expensive approach gives far better results by any standard you choose to measure it, than the very much more expensive one. That it also enables superb cross-London inter-regional services is nice, but the justification, the **deciding reason**, is economic; the consequent inter-regional services, never before even dreamed of, are merely a **reinforcing reason**.

Insofar as anyone has tried to make a considered argument against Euston Cross, as opposed to simply ignoring it and hoping it would go away, the only significant objection seems to be that it would take longer, and thus delay the opening of HS2 (but given the seven-year extension in the latest plans, that objection would seem to be no longer critical). I have also seen it stated that it's a far more risky project, as it's beneath the existing stations (St. Pancras as well). I think this second objection trivial, as no such objection is raised against the Crossrail 2 proposals – the Euston Cross platforms would be parallel to and to the north of those of Crossrail 2; indeed the development of Euston Cross and the Euston station of Crossrail 2 should proceed in tandem.

It may be thought that developing Euston Cross would delay the opening of HS2 Phase 2B – the GC-gauge lines beyond Crewe, to Manchester and Bamfurlong Junction on the WCML just south of Wigan. Actually it wouldn't; what it would delay is the introduction of GC-gauge services on all of HS2, until Euston Cross was ready to accommodate them, but the rest of HS2 could be opened as soon as the lines were ready, using classic-compatible trains temporarily, for all services. These would serve the existing, unredeveloped Euston, where room would have been made for them by rerouting the WCML suburban services to Tring and Milton Keynes onto Crossrail (a good idea anyway, as it balances the number of services at east and west ends, avoiding the need to turn back trains at Paddington,) and by rerouting the Watford DC electrics onto the East London Line. Also, several of the current classic services would simply become classic-compatibles, of course. (The figures backing up this argument are contained in the 'WCML Service Plans' article.)

I have called the Euston Terminal plans an impending catastrophe, and stated that there is a danger with them even more fundamental than the expenditure of vast amounts of money, the severe environmental damage to the surrounding area and the immense public inconvenience over a prolonged period, to achieve what, in public perception, would be no better than what exists already – a congested, inconvenient terminal station. That even-more-fundamental danger is that it would damage, likely destroy, the case for further high speed lines.

In developing Euston Cross for HS2 and HS1, we would also have made provision for HS4 and HS11/HS12. Its costs are therefore shared over 3 HS routes, not just one (HS1 is, of course, already in existence). That is why the cross-London interconnections make such good economic sense. But if Euston

Terminus were redeveloped, there would be no such synergy, and HS4 and HS11/HS12 would each have to be justified individually, with Euston-type redevelopment and extension of Paddington and Liverpool St. respectively. I think these are non-starters, quite apart from the expense, environmental damage and inconvenience. After the experience of Euston, the public would, I believe, be uncompromisingly hostile to the idea of further high speed railways in London, for so little perceived gain.

In short, and bluntly, I believe that persisting with the misconceived Euston Terminus redevelopment will kill off High Speed railways in the UK, for the foreseeable future, possibly for ever, and that, by not addressing this issue, we are sleepwalking towards disaster.

Apotheosis of the Network Plan

I cannot stress too strongly that the above strategy for London's HS provision grew out of the network plan, and not vice versa.

In developing the route and service plans articles, I did indeed associate pairs of routes on opposite sides of the capital, and exchange services between them – the original plan of the 'Railway Lords' for Euston Cross, linking HS2 to HS1 for international traffic from beyond London, and the realisation that this could even more sensibly be used by intranational traffic, was the inspiration behind that.

The thinking in the original Euston Cross plan was to run classic-compatible 'Javelin' services between Kent and WCML locations like Milton Keynes. My initial reaction to that was that it would double the number of platforms required at Euston Cross, thinking that, in the conventional wisdom, GC-gauge and classic-compatible trains could not share the same platforms. Accordingly I decided that the inter-regional HS services should be GC-gauge only, minimising the number of platforms required since these unavoidably require new infrastructure, and that classic-compatibles should use the appropriate existing terminal station. I can't say where the idea for variable platforms came from – it was just suddenly there in my head, fully formed. I've never read of such an approach, and cannot find anything like it on the web, so I claim the contents of appendix B as an original idea (but would be amazed if no-one else had ever thought it). But even though the original problem had thus disappeared, I still liked the idea of GC-gauge only across London, and classic compatibles to/from the terminals, and have retained it throughout the plans.

Only when the route and service plans articles had all been written, (except the Scottish one, which is new and not relevant in this context,) and overall cross-London inter-regional route loadings became available, did it become clear that the entire seven HS lines serving London could be accommodated in just two stations, Euston Cross and Pancras Cross, each of which is approached by a single pair of lines. This was totally unexpected, and could not have been predicted in advance. (During the route and service plans development, I implicitly assumed that each pair of corresponding routes would have its own cross-London route and station.)

I regard this as an unambiguous, incontrovertible, and easily understood vindication of the network plan. A lot of the benefits of the planning process are rather nebulous – of course it's helpful to know all the details of what could be provided, but assigning a monetary value to such knowledge is very difficult. But it should readily be possible for a competent cost and works accountant (not me!) to come up with a cash value for the savings afforded by the cross-London inter-regional connections, as compared with any other possible HS provision.

Another real, tangible benefit, which also became apparent only at the end of the planning, is in deciding the order of implementation of the several routes. Initially, I assumed that HS3 would be the leading candidate after HS2, given the need to replace HS2's Leeds arm by something more suitable (and to keep the Tykes quiet, if possible). Also, I assumed it would be a strategic imperative to reach Scotland with GC-gauge at the earliest possible opportunity. These were reasonable assumptions at the time, but, in the event, quite wrong. The leading candidate after HS2 is clearly the HS4/HS11 pair, since their cross-London route has already been built and Euston Cross is just waiting for them to start using it.

All regions, naturally, want their own HS route to be first after HS2, and all of them are able to make a plausible case, since they all have a very real need for it. But the above decision is clear, unbiased, utterly compelling and completely impersonal, and everybody can understand it and will, I believe, accept it.

Implementing HS4 necessarily involves implementing HS7 also – at least the southern half, below Birmingham. HS7's Birmingham approaches exactly duplicate those of HS2, and are most efficiently implemented simultaneously with HS2, even as far as track-laying. And so on and so on. We could easily get into far too much detail here, but see appendix D for a suggested implementation schedule. (The various Route and Service Plans articles have been revisited, and the service plans adjusted as necessary to conform with appendix D.)

Envoi

My network plan is, of course, unashamedly maximalist – every single HS route that I think could possibly ever be justified. I don't believe there's a single conceivable one that I've missed. It may well be judged a grotesque overprovision. But that is to mistake its purpose.

I originally wrote this article to argue the need to develop a plan for the complete HS network that the UK will eventually need. Nobody seemed interested in this – they still don't – and I believe that there are serious dangers in this omission. The plan has been developed to the best of my ability and imagination, and naturally I will defend it. But the reader may reject it in part or entirely and I won't grieve; if he or she is persuaded by and accepts the basic premise of the **need** for such a plan, then my illustrative effort will have served its purpose, and I challenge them to produce a better one of their own.

Appendix A – The Background to this Article; Related Articles

This article began life as my submission to the HS2 Phase 2 Public Consultation process, in late 2013.

It seemed hardly reasonable to argue the need for an overall network plan, without giving my own ideas on what it should look like. So I started to describe individual HS routes, and their service plans, and how these interacted with the services on other HS routes, and then the service plans of associated classic routes, and how these interacted with the HS services. It all metastasised into a dreadful mess, a mixture of many different levels of detail, with no overall focus, and the fundamental argument lost in the verbiage. Clearly, a single article was insufficient.

Accordingly, I developed a separate article for each individual HS route (or, occasionally, for a linked pair of routes). These all follow a standard pattern. They contain an introductory section explaining the purpose and method, and summary information about the route. This section is functionally the same for all the articles, differing only in the details specific to the particular route(s). The idea is that each article can be read alone, without the reader having to refer to explanatory matter elsewhere (there is enough unavoidable cross-referencing anyway). This is followed by the Route section, describing the proposed route in detail, illustrated with maps, and giving map references for all important infrastructure features. The route section concludes with an overall map of the particular route, (and, in a few cases, a large scale map of how the route traverses a particular city, London, Leeds and Glasgow, specifically,) and one of the overall network. The third major section gives the service plans. Whereas the route section describes the complete route, in its final manifestation, as far into the future as the proposals consider, the service plans explain how that state is reached, thus, the order in which the various sections are opened, and the partial services which run on those sections (the idea is always to get useful services running as soon as possible, to maximise the benefits of the investment). Following the service plans is a new section, giving estimated journey times between all stations. This only became possible when the new information of 'Same Speed Railways' appendix B was discovered, and is an immensely important enhancement. Finally, there may be appendices, when there is important but peripheral detail that needs to be included, but which would clutter up the argument if included in the main text.

There are now 11 such articles:

1. 'HS1 Route and Service Plans'. HS1 is the existing route to the Channel Tunnel. Three short extensions are proposed, but the main change is linking to HS2 via Euston Cross, and the service plans for inter-regional services between the West Midlands / North West and Kent / East Sussex.
2. 'HS2 Route and Service Plans.' HS2 is largely the existing proposal to the West Midlands and North West – the western arm of phase 2. (The eastern arm is detached and becomes part of HS3 and HS7.) The service plans are different, however. It connects across London to HS1, via Euston Cross. A very speculative and extra-long-term Scottish extension is also considered.
3. 'HS3 Route and Service Plans'. HS3 is the route to the North East and Scotland, via the East Midlands and West Yorkshire. This is the most fundamental, biggest and most complex of the various plans. HS3 has very extensive interactions with other routes. It connects across London with HS5, via Pancras Cross, to Sussex, West Kent and South Hampshire. The route between Nuthall North Junction, near Nottingham, and Newcastle is shared with HS7. HS3 provides for a proper city-centre station in Nottingham (as HS7 does for Derby).
4. 'HS4 Route and Service Plans'. HS4 is the route to South Wales, and, in conjunction with HS7, to Bristol and the West Country. It connects across London with HS11, to Essex and North Kent and, via HS12, to East Anglia. HS4 serves South Wales and Bristol / West Country directly by

alternate services, with cross-platform interchange with HS7 at Bristol Parkway HS to the other, i.e. Bristol / West Country, and South Wales. HS4 has a notably close, symbiotic relationship with the classic GWML.

5. 'HS5 Route and Service Plans'. HS5 is the HS Brighton Line, serving, besides Brighton, Newhaven, Eastbourne, Tunbridge Wells, Littlehampton, Bognor, Chichester, Portsmouth and Southampton. It connects across London with HS3, to the North East and Scotland, and HS6, to West Anglia, and, via HS10, to Lincolnshire and Hull.
6. 'HS Eastern Routes and Service Plans (HS6 and HS10)'. HS6 is the route to Norwich and King's Lynn, via Cambridge and Ely. HS10 is the extension (after a section of HS8) into Lincolnshire, serving Lincoln, Gainsborough and Hull.
7. 'HS7 Route and Service Plans'. HS7 is the NE/SW route from Newcastle to Plymouth, via Birmingham and Bristol, and also, in association with HS4, to South Wales. From Newcastle to Nuthall North Junction, it shares route with HS3. HS7 serves Bristol / West Country and South Wales directly by alternate services, with cross-platform interchange with HS4 at Bristol Parkway HS to the other, i.e. South Wales, and Bristol / West Country.
8. 'HS Transpennine Routes and Service Plans (HS8 and HS9)'. HS8 is the southern transpennine HS route, from Liverpool and Preston to Manchester and Sheffield, then on to Nottingham, Peterborough and Norwich, sharing route as appropriate with HS3 and HS6. HS8 also has a branch between Huddersfield and Ladybower Junction, enabling HS services between Huddersfield and Sheffield. HS9 is the northern transpennine HS route, sharing route with HS8 between Liverpool / Preston and Guide Bridge, then on to Huddersfield, Leeds and York, with terminal destinations of Hull, Scarborough, Middlesborough and Newcastle. HS8 has a notably close, symbiotic relationship with HS and classic services at Sheffield. HS9 has a notably close, symbiotic relationship with HS and classic services at Huddersfield.
9. 'HS East Anglia and N. Kent Routes and Service Plans (HS11 and HS12)'. HS11 is the route to Essex and North Kent, to Dover via Shenfield, Southend, Grain, Faversham and Canterbury. HS12 is the extension from Shenfield to Norwich via Colcheater, Ipswich and Beccles. HS11 connects across London with HS4, to South Wales and, via HS7, Bristol and the West Country.
10. 'HS Scottish Routes and Service Plans (HS13 and HS14)'. HS13 is the route from Edinburgh to Glasgow, and on to Kilmarnock and Ayr, with a branch from Glasgow Airport to Dalmuir. HS14 links to HS13, in both directions south of Stirling, then extends to Aberdeen via Perth, with a branch to Dundee. HS3's Scottish services extend beyond Edinburgh to Glasgow via HS13. The classic services between Edinburgh and Perth / Dundee / Aberdeen via Fife and the bridges are closely linked with HS14.
11. 'Cross-London Inter-Regional Connections'. This is a short, but immensely important article explaining the HS connections across London via the new HS stations of Euston Cross and Pancras Cross, giving a large scale map of the traverse of London, and layout diagrams of all relevant junctions / stations. The vision expounded here did not become fully apparent until all the relevant route and service plan articles had been written, and it became clear that just two through, HS stations, with just two approach tunnels each, would be sufficient to accommodate all seven HS routes serving London, at the maximum service levels proposed, as far into the future as the plans consider (some 50 years). This article is the synthesis of the relevant information from all the preceding ones, and shows what a catastrophe the proposed redevelopment of Euston terminus would be. It is the final culmination and justification of the Network Plan – it just couldn't have been written without writing about all the other parts of the network first; only then did the conclusions become apparent.

The routes proposed in the above articles have all been exhaustively checked against satellite maps, and were available, on that basis, at the time of writing. There is of course no guarantee, in the absence of an approved network plan, that this will continue to be the case.

The article 'HS2 and Classic Service Plans' analyses HS2 Ltd.'s proposed service plans at phases 1 and 2, both on HS2 itself, and on the associated classic route(s), and highlights the consequent severe degradation of service quality on the latter.

'Maximum Loadings of the HS Network' is a very short article whose contents are self-evident. Specifically it highlights all sections with a loading in excess of 16tph, and makes a few preliminary remarks on haw the capacity constraints could be eased.

'Same Speed Railways', mentioned many times previously, is the most technical article of all. The main body defines what a same speed railway is, what benefits it brings, and how it should be designed. The new and immensely important appendix B explains how to calculate accelerations, decelerations and capacity on HS railways, and is the technical source for the techniques which have enabled estimated journey times to be produced.

'Estimated Journey Times for High Speed Services' says exactly what it is. It collects together in one, readily accessible place, the estimated journey times section of each Route and Service Plans article.

In addition to the HS route and service plan articles listed above, service plan articles are being produced for the corresponding classic routes (the routes themselves exist already, of course, and very little significant new infrastructure is proposed). This is still very much work in progress, but the following articles have already been written:

- WCML Service Plans associated with HS2
- MML Service Plans associated with HS3
- GWML Service Plans associated with HS4

The service plans on the classic route correspond exactly with those of the associated HS route, since it is the piecemeal development of the HS route that causes new service plans, for both HS and classic routes, to be introduced. The linkages between service plans for classic and HS routes are many and close, especially for GWML/HS4, which really are, logically, parts of the same entity. (That is essentially true in all such cases, but for HS4/GWML it's manifestly obvious.) In fact, although it is a convenient shorthand to refer to the HS network, and I shall continue to do so, there is actually no such thing. There is only the **railway** network, certain lines of which happen to be high speed.

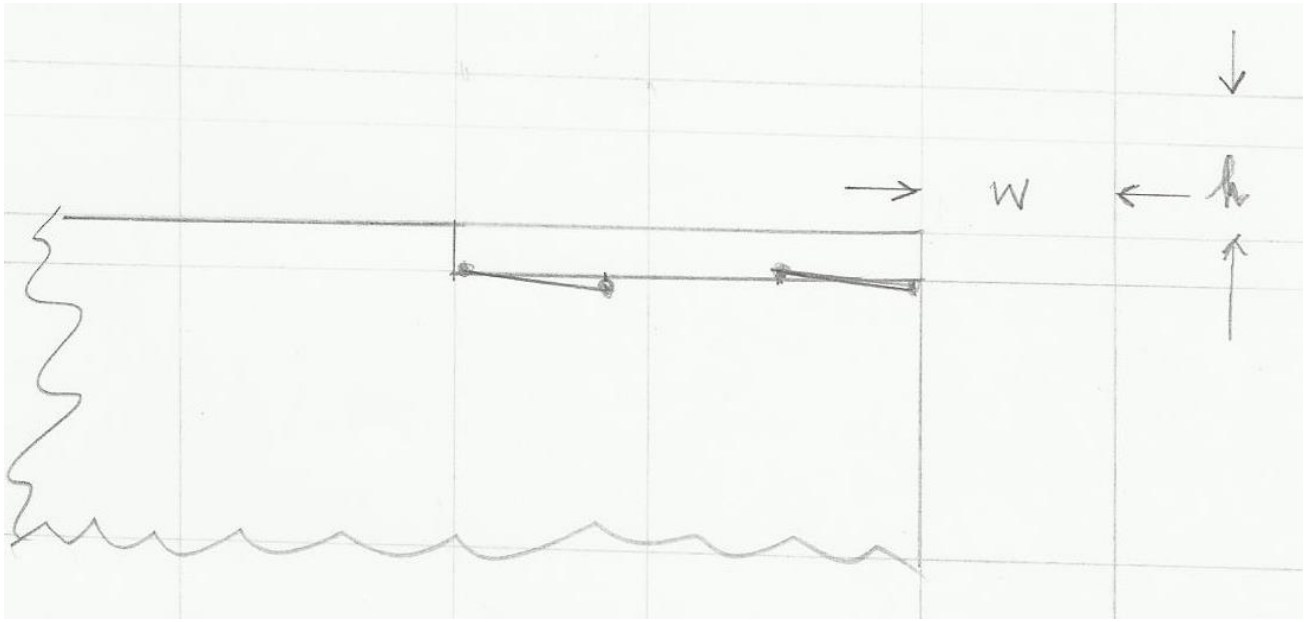
Having written all the supporting articles listed above, it was then time to recast this current, the original 'network', article to its proper polemical and overall summary function. An associated article 'Towards a High Speed Network – the Maps' contains overall maps for the complete network, the Euston Cross and Pancras Cross subnetworks, annotated maps for each individual route (or route-pair) and large scale maps of the traverses of London, Leeds and Glasgow. It contains information on the map-making process, and is produced as a separate article as it has a purely documentary, rather than polemical, function.

Appendix B – Variable Platforms

High Speed railways are built to GC- (loading) gauge, which is the largest of the various European standards, and provides for very comfortable, very roomy trains. Double-deckers fit easily within this gauge. Normally one would think of these as high-capacity metro-type trains, but in Switzerland, for example, Inter-City expresses are often double-deck, and very fine they are. Classic-compatible trains, i.e. those built to the British standard loading gauge, can run without problem on GC-gauge lines, but cannot use GC-gauge platforms, since these are lower (by about 6") than those for British gauge, and also further from the track centre-line (by about 8"), so if a classic-compatible train were to stop at a GC-gauge platform, there would be a quite large gap (both horizontal and vertical) between train and platform, which even I don't need the Health and Safety Fascists to persuade me is dangerous. GC-gauge trains cannot run at all on British loading gauge lines, since they would foul the platforms (and probably lots of lineside structures also, not to mention overbridges and tunnels).

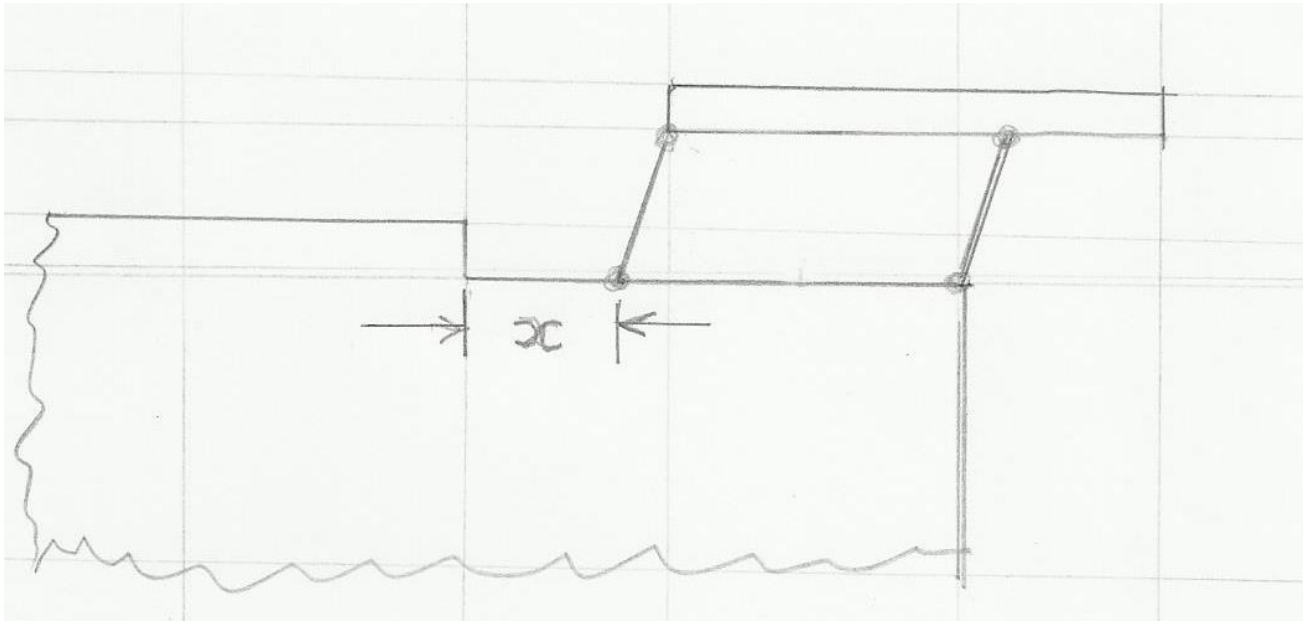
If GC-gauge and classic-compatible trains must share the same (GC-gauge, obviously) track, then this would ordinarily double the number of platforms required, since classic-compatible trains cannot use GC-gauge platforms, and vice versa. However, this applies only (!) if the platforms are fixed (as every platform in existence currently is; at least I've never heard of any that aren't). As a piece of pure blue-sky thinking, I would like to suggest the idea of variable platforms, which can reconfigure themselves as to both height and lateral reach, so they could be used by both GC-gauge and classic-compatible trains (in principle they could reconfigure themselves automatically, recognising the type of train about to stop there).

There are many ways this could be effected; the way explained below has the serious advantage of extreme mechanical simplicity. I take as a design principle that the default configuration should be for GC-gauge, with the platform reconfiguring itself when required to accommodate a classic-compatible train, afterwards reverting to the GC default, (since, as already pointed out, classic-compatible trains can run through GC-gauge platforms without problems, provided they don't stop, whereas GC-gauge trains would foul classic-compatible platforms,) and that in this configuration, the platform should be flat. We have this situation:



In the above diagram, h is the height difference between classic-compatible platforms (higher) and GC-gauge, and w is the difference in the lateral distance from the track centre line between GC-gauge platforms (wider) and classic-compatible. As can be seen, there is a 'plank' of platform, lying flush with the rest of the platform, below which are rods and pivots, inactive in this state.

When it is necessary to accommodate a classic-compatible train, the 'plank' is raised by rotating the rods, thus:



The critical value here is x, the length of the rods. This is given by:

$x = (h^2 + w^2)/2w, = h^2/2w + w/2.$

(It is left as an exercise for the reader, to verify this formula.)

I am concerned here only to demonstrate the feasibility of the idea, not to develop an engineering design (in which there would, of course, be no gap between the different sections of platform). It is, as is clear from the diagrams, extraordinarily simple (which is always an advantage in engineering terms). Mechanical reliability would be critical of course; it always is. But it would reduce by half the number of platforms required when GC-gauge and classic-compatible trains must share the same track, which would seem a very worthwhile saving.

I imagine that the platforms, or at least the relevant areas thereof, would have to be gated, and passengers admitted only when the train was actually arriving; it would seem a bad idea to have passengers standing on platforms which suddenly moved beneath them.

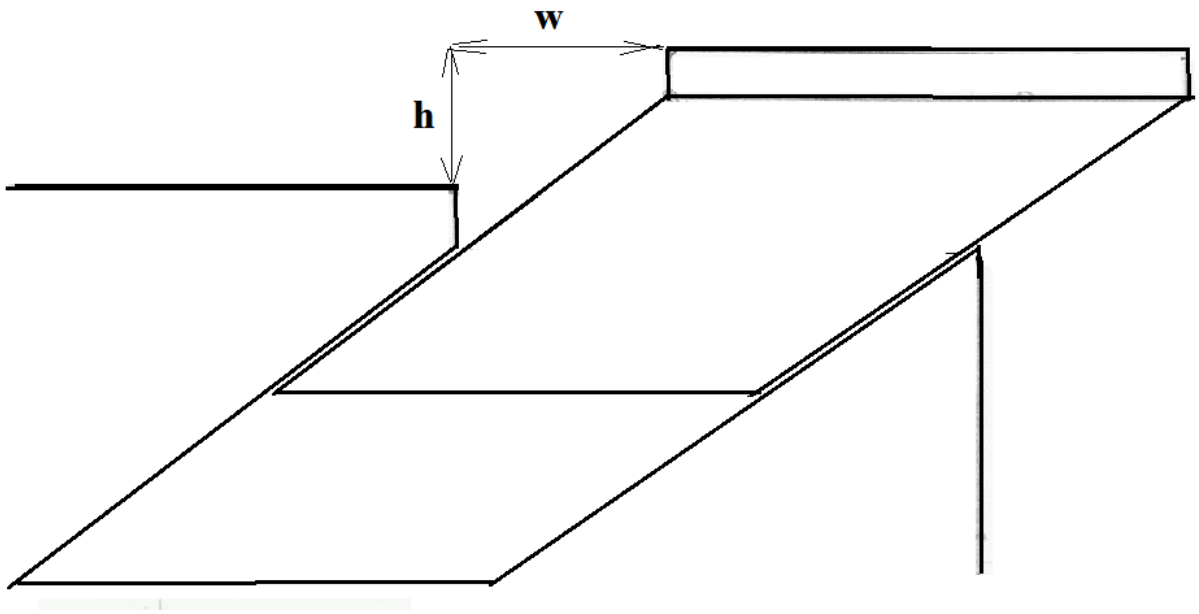
(I have located on the Web the values for GC and CC trains of 760mm and 915mm for platform height above rail level, and 1575mm and 1371mm for distance of platform edge from rail centre line. I don't know how reliable these are, but the resulting values are h = 155mm (very slightly over 6"), w = 204mm (almost exactly 8") and x = 161mm (6.34"). The above diagrams are drawn to scale with these values.)

This all has the very important consequence that absolutely any existing station, provided that it offers or could be made to offer GC-gauge lineside space, (i.e. no protruding infrastructure that would foul a GC-gauge train), could in principle become a High Speed station simply by installing variable platforms on some or all lines. Obvious candidates are Crewe, Nottingham and Derby (and possibly Edinburgh

Waverley and Glasgow Bellgrove). The only valid reason to build dedicated High Speed stations is if the existing ones are already overloaded and have no spare capacity, or available space for extra platforms, to accommodate the high speed trains. I think that Crewe has platforms to spare (and GC-gauge trains could rejoin HS2 to the north of the station, where it emerges from its tunnel). I know that Derby has space available (on the east side) certainly for two and possibly for four extra platforms. I also know that Nottingham, where the trackwork has just been extensively reconfigured, has made passive provision for one more platform (on the south side) and I believe could fit in two more (that certainly used to be the case).

London, Birmingham, Manchester and Leeds do of course genuinely need dedicated high speed stations.

I said earlier that there are many ways that variable platforms could be implemented. Here's another version, conceptually even simpler:



Conceptually simpler, indeed, but more complex in operation: the platform must be maintained in its raised position actively, by the hydraulics, or by some additional locking mechanism. The previous arrangement is purely mechanical in operation, and can be maintained in its raised position statically, by struts beneath the plank.

But I really don't know why the rotating version occurred to me so much more readily, and this one months (even as much as a year!) later. Aesthetics, I suppose (and the formula was irresistible).

Appendix C – Accommodating the Passenger Flows

Whereas I am confident of the ability of the proposed cross-London GC-gauge infrastructure to handle the service loadings of the trains, I am less sure of its ability to handle the very large passenger loadings. While the benefits of inter-regional travel are very real, it has to be recognised that, for the services south and east of London in particular, the bulk of the traffic will be commuters to and from London itself. The bulk of the long distance traffic on the other routes will also be to and from London. The **economic** case for the cross-London GC-gauge connections is that this is a much less expensive way of providing the new infrastructure, (which is unavoidably needed, since GC-gauge trains cannot use UK gauge infrastructure,) than the alternative of heavy, extensive, monstrously inconvenient and hugely unpopular rebuilding and enlargement of the classic terminals. This is the **deciding** reason. That this solution is more elegant and more efficient, and provides new facilities undreamed of previously, will not move the stony hearts at the Treasury. Nor, indeed, should it, as this is merely a **reinforcing** reason, not a deciding one.

We thus face the situation where trains will arrive in London full, empty almost completely and then refill, and proceed out to the other side. Two approaches are available to accommodate the passenger volume, the first is provided in any case, and the second is available if it is decided the first is not by itself sufficient.

All trains on the Euston Cross routes (GC-gauge and classic-compatible, and the regional metro services on the relevant classic routes too,) stop at Old Oak Common and/or Stratford. The idea is that passengers for West End and City destinations switch to Crossrail at those points, reducing the passenger loading of Euston Cross (also of Euston, Paddington and Liverpool Street). Old Oak Common to Stratford (strictly, to Whitechapel, just short of Stratford, after which the Abbey Wood arm diverges,) will be the highest loaded section of Crossrail, so this strategy is endangered if the inbound trains are already full on arrival at these points, and passengers trying to make the connection (likely with luggage) are not able to. The envisaged service level on Crossrail's central section is 24tph, with 32tph intended later. If these extra 8tph were run as a shuttle between Old Oak Common and Stratford, then passengers connecting from high speed (and other) services would be **guaranteed a completely empty train** at least once every 7 / 8 minutes (thus an average wait of 4 minutes for it). The shuttle trains would be of special stock, with extra luggage capacity, and a clearly distinctive livery. The station displays at Old Oak Common and Stratford would include the time of the next shuttle, as a distinct item of information. This, I suggest, is terrific customer relations – telling connecting passengers 'these trains are specially for you!' In addition, the Jubilee line starts at Stratford, providing initially empty trains to Docklands, London Bridge (City), Waterloo and the West End. Likewise the Overground services to Richmond and Clapham Junction via Willesden, so these trains also are initially empty. If the Bakerloo (and likewise the Overground) were extended from Queens Park to Old Oak Common, then that would likewise provide initially empty trains to the West End and Waterloo. (I've never seen this suggested, which astonishes me. I can hardly believe nobody else has thought of it. Even Boris's new transport plan deals at length with extending the Bakerloo southwards to Hayes, but says nothing about the northern end.) For the Overground services, 4tph would run from New Cross to Watford Junction, 4tph from Crystal Palace to Harrow & Wealdstone, and the remaining 8tph (4tph each from West Croydon and Clapham Junction) to Old Oak Common.

The equivalent provision on the Pancras Cross routes is the GC-gauge station at Victoria Low Level, connecting inter alia with Crossrail 2 and Crossrail 4, which provides a significant counterweight to

Pancras Cross. I think the likelihood is that more inbound passengers (from south of London) will alight at Victoria, and outbound passengers join at Pancras Cross, and vice versa. I can't **prove** it, but I don't think there's the same likelihood of a train emptying and refilling at the same station on this route, as there would be at Euston Cross, without its Old Oak Common and Stratford satellites.

But the possibility must be faced that the above provision would still not be adequate for the passenger flows. There are two possible ways forward. If it's **nearly** adequate, then implementation of the extra 2 platforms (to 8) for which passive provision has been recommended, may do the trick. If it's **still** not adequate, then the ultimate solution must be used. This is to provide separate platforms for passengers joining and leaving the train, thus on both sides of each track. Passengers first alight on one side of the train, and then, (once they have alighted,) other passengers join from the other side. I know of only one instance of this extreme provision, on the Munich S-Bahn, at Hbf and the next two city centre stations to the east of it. (If there are any others, I would be pleased to hear of them.) Once passengers have grown accustomed to the arrangement, simultaneous alighting and joining may be practicable. A further refinement could be to open half the doors alternately, on one side of the train, for alighting passengers, and the other half, on the other side, for those joining. Joining and alighting passengers would thus form one continuous stream with no conflicting movements. The passengers would, of course, need to know in advance precisely which doors were which.

Each platform (except the two outermost) serves two adjacent tracks, and is either for passengers alighting, (from both tracks,) or for joining, (to both). The alighting platforms do not need to be as wide as those for joining, since passengers have no need to wait there, but they do need to be supplied with more means of ready egress, more escalators especially, since passengers need to clear the platforms as quickly as possible. The platforms will (of course) be gated, as at all modern, high-capacity, metro stations.

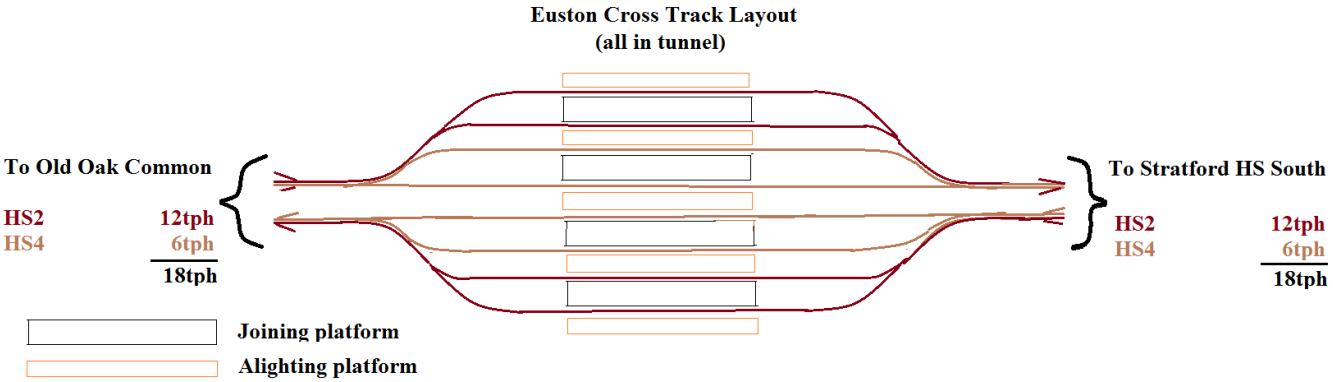
Naturally I can't say whether or not this extreme provision would in fact be necessary, but the possibility certainly needs careful consideration. It would definitely be prudent to make **passive** provision for it (again!) – leaving enough space between adjacent tracks for an alighting platform to be added later, if necessary. This applies to all the London through stations. Euston Cross, Old Oak Common, Stratford HS South, Pancras Cross and Victoria LL.

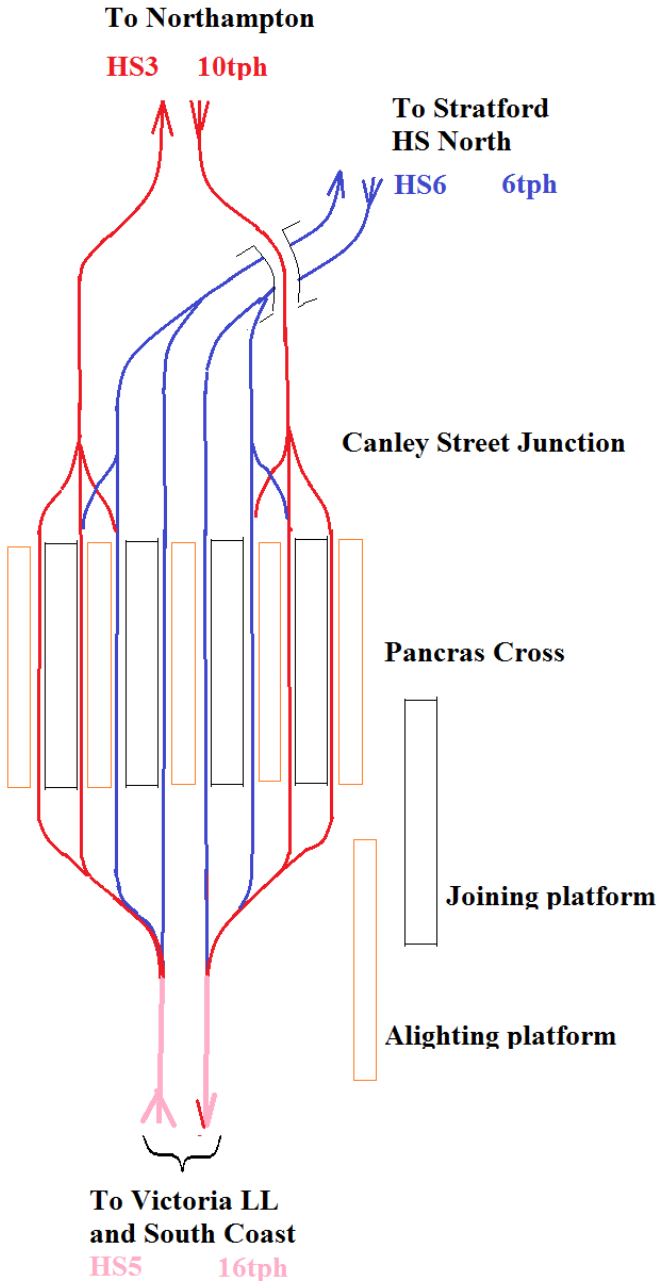
Note again that all this is concerned solely with accommodating the passenger volumes. The number of trains involved is unchanged, (so the same twin tunnels remain sufficient to accommodate them). By increasing the number of platforms, longer stopping times are available for the trains to empty and refill. By providing separate platforms for alighting and joining, the passenger flows are kept completely separate, out of each other's way, so the trains actually empty and refill more quickly.

Thinking ahead, and making passive provision for all recognised eventualities, is what it's all about.

(I may well be being excessively cautious in this matter, but if so, it's an error in the right direction! After all, the Euston Cross route with 18tph and with 3 platform faces in each direction still allows for a maximum stopping time of 10 minutes, and the Pancras Cross route very slightly longer. But the matter is very definitely still worth bringing up and considering in detail.)

Just for interest, the following diagrams show the two principal GC-gauge stations at their maximum extent, to accommodate maximum passenger flows, as described above:





Victoria LL would be similar to Euston Cross, and Stratford HS South similar to Pancras Cross. Old Oak Common is slightly more complicated, but the same principles apply.

Appendix D – Suggested Order of Implementation of the Various HS Routes

The next pair of routes to be implemented following HS2(/HS1) is HS4 and HS11, since their cross-London connection has already been implemented as part of HS2. Each route is of course actually implemented in segments, so the actual order of implementation is by segment, and segments of different routes can and will be mixed together in the order of implementation. The following list of segments, for the various routes, is drawn from the service plans section of the relevant Route and Service Plans article (with a few amendments, where it is necessary to split what was originally seen as a single segment). HSm-n means segment n of route HSm, 'Sim' means simultaneous with (implemented at the same time as) other segments, and 'Pre' means (must be) preceded by, thus follows, other segments. (Note: 'preceded by' does not imply that the work cannot **begin** before the preceding segment has been completed, but rather that it can't be completed – thus put into service – before that preceding segment has also been completed and put into service. It could well happen that both are completed and put into service simultaneously.)

Segment	Contents	Sim	Pre
HS1-1:	Pilgrims' Way Junction – Maidstone HS / Saltwood HS Junction – Dover Priory / Ashford West Junction – Hastings	HS2-3	-
HS2-1:	Queens Park Jn – Birmingham HS / Handsacre Junction	HS7-1	-
HS2-2:	Streethay Junction – Crewe HS South Junction	-	HS2-1
HS2-3	Old Oak Common North Junction – Euston Cross – Stratford HS South Junction – Woodgrange Rd. Junction	-	-
HS2-4:	Crewe HS South Junction – Manchester HS / Bamfurlong Junction	HS8-1	HS2-2 HS2-3
HS2-5:	Preston – Carlisle	-	HS2-4
HS2-6:	Carlisle – Riccarton North Junction	-	HS2-5 HS3-7
HS3-1:	West Hampstead Junction – Northampton station	-	-
HS3-2:	Northampton station – Watkin Rd. Junction – Regent St. Junction	-	HS3-1
HS3-3:	Pancras Cross – West Hampstead Junction	-	-
HS3-4:	Watkin Rd. Junction – Humberstone Rd. Junction / Swain St. Junction – Humberstone Rd. Junction / Humberstone Rd. Junction – Nuthall South Junction / Stanford Junction – Notttingham Midland station	HS7-2	HS3-2 HS3-3
HS3-5:	Nottingham Midland station – Nuthall North Junction – Altofts Junction – Leeds New Lane / Altofts Junction – York	HS9-1	-
HS3-6:	York – Newcastle	-	HS3-5
HS3-7:	Derwent Hill Junction – Hexham – Edinburgh / Paradise Junction – Stocksfield	-	HS3-4 HS3-6 HS13-2
HS4-1:	Old Oak Common West Junction – Magic Roundabout Junction	-	-
HS4-2:	Old Oak Common East Junction – Old Oak Common West Junction	-	HS2-3 HS4-1

Segment	Contents	Sim	Pre
HS4-3:	Magic Roundabout Junction – Cardiff HS /	HS7-3	HS4-1
	Swindon station – Mannington Junction		HS4-2
HS4-4:	Cardiff HS – Swansea	-	HS4-3
HS5-1:	Pancras Cross – Brighton /	-	HS3-3
	Hickstead Junction – Southerham HS Junction – Newhaven /		
	Southerham HS Junction – Eastbourne		
HS5-2:	Winders Hill Junction – Tunbridge Wells	-	HS5-1
HS5-3:	Finches Shaw Junction – Arundel HS – Littlehampton / Bognor	HS6-1	HS5-1
HS5-4:	Barnham Junction – Southampton	HS6-2	HS5-3
HS6-1:	Pancras Cross – King's Lynn	HS5-3	HS5-1
HS6-2:	Ely HS South Junction – Norwich	HS5-4	HS6-1
HS7-1:	Birmingham approaches:	HS2-1	
	Birmingham Curzon St. – Water Orton West Junction /		
	Water Orton West – North Junction /		
	Water Orton North – South Junction /		
	Water Orton West – South Junction /		
	Water Orton South Junction – Birmingham Interchange		
HS7-2:	Water Orton North Junction – Nuthall North Junction /	HS3-4	HS2-1
	Awsworth Junction – Strelley Junction		HS7-1
HS7-3:	Birmingham Interchange – Bristol Temple Meads (BT and HS)	HS4-3	HS7-1
HS7-4:	Bristol Temple Meads HS – Plymouth	-	HS7-3
HS8-1:	Liverpool Lime St. – Kenyon West Junction /	HS2-4	-
	Kenyon West Junction – Kenyon South Junction /		
	Kenyon West Junction – Kenyon North Junction		
HS8-2:	Kenyon West Junction – Broughton Junction – Manchester HS –	-	HS3-5
	Sheffield HS – Beighton Junction /		HS8-1
	Preston – Gibb Farm Junction – Bolton – Broughton Junction /		
	Gibb Farm Junction – Bamfurlong Junction		
HS8-3:	Ladybower Junction – Paddock Junction	-	HS8-2 HS9-2
HS8-4:	Edwalton Junction – Ely HS North Junction /	-	HS3-4 HS8-2
	Ely HS North Junction - Ely HS South Junction /		
	Ely HS North Junction - Ely HS East Junction		
HS9-1:	Gelderd Rd. North Junction – Leeds New Lane –	HS3-5	-
	Garforth West Junction – Micklefield Junction /		
	Garforth West Junction – Garforth East Junction		
HS9-2:	Guide Bridge HS Junction – Paddock Junction –	-	HS8-2 HS9-1
	Gelderd Rd. North Junction		
HS10-1:	Thurlby Junction – Hull	-	HS6-1 HS8-4

Segment	Contents	Sim	Pre
HS11-1:	Manor Park Junction – Shenfield HS Junction	-	-
HS11-2	Stratford HS South Junction – Manor Park Junction	HS4-2	HS11-1
HS11-3:	Shenfield HS Junction – Southend Airport	HS4-3	HS11-2
HS11-4:	Southend Airport – Faversham		HS11-3
HS11-5:	Faversham – Dover Priory		
HS12-1:	Shenfield HS Junction – Shenfield North Junction		
HS12-2:	Shenfield North Junction – Norwich		

The Scottish routes are almost entirely independent of the above. The only linkage is that HS3, in order to be opened to Scotland (HS3-7), relies on HS13 being in service between Edinburgh and Glasgow St. Enoch.

Segment	Contents	Sim	Pre
HS13-1:	Gyle Junction – Bellgrove – Glasgow Airport Parkway / Kirkliston Junction – Humbie Junction	-	-
HS13-2:	Saltmarket Junction – St. Enoch / Clyde Junction – St. Enoch / Glasgow Airport Parkway – Dalmuir	-	HS13-1
HS13-3:	Glasgow Airport Junction – Dalry – Kilmarnock – Ayr	-	HS13-2
HS14-1:	Kinnaird Junction – Bannockburn Junction / Bankhead Junction – Bannockburn Junction / Bannockburn Junction – Dunblane Junction – Perth	-	HS13-1
HS14-2:	Perth – Burrelton Junction – Dundee	-	HS14-1
HS14-3:	Burrelton Junction – Craigo Junction	-	HS14-2
HS14-4:	Craigo Junction – Aberdeen	-	HS14-3

The Overall HS Network is implemented as a number of (quite large scale!) work packages. It is assumed that work may be in progress on several routes simultaneously in a package. For full details of the service plans mentioned, refer to the appropriate Route and Service Plans article. The following description of the implementation order is intended to explain **why** this order is chosen, and the benefits intended to be delivered by each WP.

WP-0

HS2-3
HS4-2
HS11-2

WP-0 is the building of the complete cross-London inter-regional connection via Euston Cross, including the links to HS4 and HS11. It begins right at the beginning of the implementation, and is possibly the longest-running WP. Other WPs take place alongside WP-0. WP-3 is dependent on WP-0's completion for its own completion, as also is WP-4.

WP-1

HS2-1
HS7-1
HS4-1
HS11-1
HS12-1

During WP-1, HS2 is built from Queens Park Junction (on the WCML 5 miles from Euston) to Birmingham Curzon St. and Handsacre Junction, together with HS7's Birmingham approaches (everything between Water Orton North Junction, Curzon St. and Birmingham Interchange). HS2 SP1 begins (GC-gauge Old Oak Common – Birmingham and CCs Euston to Manchester, Manchester via Stoke, Liverpool, Chester, Glasgow and Edinburgh, also Birmingham to Manchester and Glasgow/Edinburgh).

Within the same work package / time frame, HS4 is built between Old Oak Common West Junction and Magic Roundabout Junction, Swindon, together with the connection from Old Oak Common West Junction to the GWML at Old Oak Common ground level station, and HS4 SP1 begins (CCs Paddington to Bristol by two routes, to Swansea and to Gloucester-Cardiff/Worcester). Also HS11/HS12 is built between Manor Park Junction and Shenfield North Junction, and HS11/HS12 SP1 begins (CCs Liverpool St. to Norwich, Lowestoft, Harwich, Clacton/Walton and Braintree).

This gives a very good preliminary CC service on all three routes.

WP-2

HS2-2
HS3-1
HS3-2

During WP-2, HS2 is extended from Streethay Junction to Crewe HS South Junction, This allows HS2 SP1A to begin – no change from SP1, but with acceleration of those CC services not stopping at Stafford.

HS3 also is built between West Hampstead Junction and Leicester station. The reason that this first segment of HS3 is still implemented this early, (further work on HS3 comes quite a bit later, at WP-6,) is twofold: firstly that it allows HS3 SP1 to begin, as soon as HS3 is opened to Northampton station (HS3-1). This is a CC service between St. Pancras and Wolverhampton, splitting there and continuing on to Liverpool and Chester. This replaces some of the classic services between Euston and the West Midlands, making more capacity available at Euston. Thus HS2 SP2 can begin, which replaces the Euston – Liverpool and Euston – Chester service of HS2 SP1A (which are now served by HS3) with CC services to Blackpool / Windermere and Holyhead.

Secondly, HS3 SP1A begins as soon as HS3 opens between Northampton station and Leicester station (HS3-2). This replaces with CCs the classic services from St. Pancras to York, via Leeds, and to Manchester, via Miller's Dale, assuming that route has been reopened, (otherwise via Sheffield – reverse – and the Hope Valley,) fast to Leicester then all major stations. A Regional Metro service between St. Pancras and Nottingham serves all major stations, and makes cross-platform connections at Leicester with the CC services. This gives a service of 4tph to every major station as far north as Derby and Nottingham, and 2tph beyond (4tph as far as Sheffield, if the Manchester trains are routed via the Hope Valley). For

Leeds this represents a half-way house to what the eastern arm of HS2 Phase 2 would have provided (since that will not now be available until WP-6).

WP-3

HS1-1
HS2-4
HS8-1

During WP-3, HS2 is extended from Crewe HS South Junction to Manchester and Bamfurlong Junction and, as HS8-1, to Liverpool. The three extensions of HS1-1 are also built. The HS1/HS2 route pair is now ready for GC-gauge services, (HS1 SP1 and HS2 SP3,) as soon as WP-0 is complete, but if it isn't, the additional GC-gauge services can run terminate at Old Oak Common, until it is.

HS2 (and of course HS1) is now complete, except for the very speculative Scottish extension, which would not be implemented until all other HS lines in England and Wales were complete. (Scotland of course already has CC services, since WP-1, and will have GC-gauge services when HS3 opens to Edinburgh, in WP-9.) There are indeed further service plans on HS2 and HS1, but these are a consequence of new (more usually changed / extended) services introduced following changes on other HS routes.

WP-4

HS4-3
HS7-3
HS11-3

During WP-4, HS4 is extended from Swindon to Cardiff, HS7 from Birmingham Interchange to Bristol, and HS11 from Shenfield to Southend Airport. This enables GC-gauge services to be introduced on HS4/HS11 and HS7, (HS4 SP2, HS7 SP1, HS11 SP2,) provided WP-0 is also complete (though implementation of WP-4 can begin before this, of course). HS4 is now complete, except for Cardiff – Swansea, which will be one of the last segments to be built (in WP-12). There will be further changes to HS4's services (a very important one coming in the next WP), but these are in response to changes elsewhere.

WP-5

HS7-4
HS11-4

During WP-5, HS7 is extended from Bristol to Plymouth and HS11 from Southend Airport to Faversham (where it has cross-platform connections with classic services to both Dover and Ramsgate). HS4 SP3 begins, introducing the CC service from Paddington to Penzance, high speed to Plymouth. HS7 SP2 (Birmingham – Plymouth) and HS11 SP2A (HS4's GC-gauge services now start from Faversham) likewise come into operation. With the minor exceptions of HS2's GC-gauge service to Preston (awaiting HS8-2, in WP-7), HS11's GC-gauge service to Dover (awaiting HS11-5, in WP-12) and HS12's to Norwich (awaiting HS12-2, in WP-12), the Euston Cross subnetwork is complete and fully operational.

HS4 remains terminating at Cardiff, HS11 at Faversham and HS12 at Shenfield North Junction until much later (WP-12 in fact). (The HS4/HS7/HS11/HS12 services are already **almost** as good as they will be at the final state of these plans.)

With the sole exception of Cardiff – Swansea, the entire HS network of HS2 and everything south and west of it (and of HS11 as far as Faversham) – i.e. the Euston Cross subnetwork plus HS7 between Birmingham and Bristol Parkway – is now in place. Focus now shifts to the Pennines and the North East.

WP-6

HS3-5
HS7-2
HS9-1

During WP-6, HS3 is built from Nottingham (Midland station, appropriately extended and modified) to Altofts Junction, then on to Leeds and York, separately. HS7 is built from Water Orton North Junction to Nuthall North Junction (where it joins HS3 to the north) and Strelley Junction (where it joins HS3 into Nottingham). This is in fact the full GC-gauge replacement for the Leeds arm of HS2 Phase 2, but with proper city centre stations in Derby and Nottingham. London services will **not** run to Leeds / York via Birmingham, but will make cross-platform connections, either at Birmingham Interchange, with services from Plymouth to York (later to Newcastle) and Cardiff to Nottingham (later to Norwich), or at Curzon St., with services from Birmingham to Leeds and Birmingham to Nottingham.

In addition the first segment of HS9, is built between Gelderd Rd. North Junction (where the Leeds arm of HS3 joins it) and Garforth (where it joins the main line of HS3 to York at Garforth East Junction) and Micklefield Junction, where it joins the classic route from Leeds to York and Hull. This segment of HS9 allows services between Altofts Junction and Garforth East Junction to travel either directly or via Leeds.

HS7 SP3 begins (services from Plymouth to York and Birmingham to York, both via Leeds, and Cardiff to Nottingham and Birmingham to Nottingham). Although a segment of HS3 has opened, there are no changes to HS3's existing services (still HS3 SP1A).

WP-7

HS3-6
HS8-2
HS9-2

During WP-7 HS3/HS7 is extended from York to Newcastle, and the transpennine routes are built: TP South, from (Liverpool –) Kenyon West Junction and Preston to Sheffield and on to Beighton Junction, joining HS3 to the south, and TP North, from (Liverpool / Preston –) Guide Bridge HS Junction to Leeds via Huddersfield.

HS7, the NE/SW route is now complete (HS7-SP3A, reflecting the extension from York to Newcastle,) and GC-gauge transpennine services are running between Liverpool and Newcastle, and between Preston and Nottingham, with classic-compatibles between Liverpool or Preston and Middlesborough, Scarborough, Hull, Cleethorpes and Norwich. (This is SP1 of both HS8 and HS9.) In addition, HS2 SP4 begins, introducing a new GC-gauge service between Hastings and Preston, and HS2's services are thereby complete (unless and until the highly speculative Scottish extension).

Focus now shifts to completing the east coast route to Scotland, and then the HS Brighton Line.

WP-8

HS3-3
HS3-4
HS8-3

During WP-8, Pancras Cross is built (just the station and its approach, but not yet the route across London) and connected to the preceding segments at West Hampstead Junction, and HS3 is built from Leicester to Nuthall South Junction (where is joins the segment opened in WP-6 from Nottingham to Leeds and York, together with the segment of the Nottingham station loop from Stanford Junction to Nottingham Midland station. The segment of HS8 between Ladybower Junction and Paddock Junction is also built. GC-gauge services are now introduced on HS3, from Pancras Cross to York, via Leeds, and to Manchester and Preston (HS3 SP2). For the time being, Pancras Cross operates as a terminal station (10tph spread over 6 platforms – no problem).

The segment of HS8 allows HS3's HS Metro service from Pancras Cross to Leeds and York to travel via Sheffield and Huddersfield, likewise HS7's Plymouth – Newcastle and Birmingham – York services. Sheffield now enjoys its full HS service, via the city centre station. The original route via South Yorkshire (Meadowhall) is still used by Ultra-High-Speed services from Pancras Cross to York via Leeds, and to Newcastle (direct to York, not via Leeds,) with first stop South Yorkshire. (This is SP3 of HS3 and SP2 of HS8.)

WP-9

HS3-7

During WP-9, HS3 is extended to Edinburgh, from Derwent Hill Junction, Consett, and from Paradise Junction, Newcastle. Services extend through to Glasgow on HS13 (completed probably many years before). HS3 is now complete (HS3 SP3A). At a consequence of GC-gauge services to Scotland on HS3, HS2's CC services from Euston are withdrawn, but HS2 services from Birmingham and Liverpool continue. (This is HS2 SP4A). HS3's service from Pancras Cross to Glasgow travels directly and non-stop to York.

WP-10

HS5-1
HS5-2

During WP-10 the HS Brighton Line is built. It extends from Pancras Cross across London via Victoria Low Level to East Croydon, all in tunnel, then on to Brighton, from Hickstead Junction to Newhaven, and from Southerham HS Junction to Eastbourne. All of HS3's GC-gauge services are extended to the south coast, except that from York to Tunbridge Wells, which terminates temporarily at East Croydon (HS5 SP1), until the branch from Winders Hill Junction to Tunbridge Wells (segment HS5-2) opens somewhat later (HS5 SP1A). This is also HS3 SP4 (SP4A when Tunbridge Wells reached) but involves no change in HS3 itself, other than that its services now originate in Sussex / West Kent.

This is a very major WP.

WP-11

HS5-3
HS6-1

HS5-4
HS6-2
HS8-4

During WP-11, the Southampton branch of HS5 is built, as is the complete HS6. This occurs in two stages. HS5 opens from Finches Shaw Junction to Arundel HS, Littlehampton and Bognor, and HS6 opens between Pancras Cross and King's Lynn. GC-gauge services are introduced between Littlehampton / Bognor and King's Lynn (HS5 SP2, HS6 SP1 also HS3 SP5).

In the second stage HS5 opens from Barnham Junction, Bognor, to Southampton, HS6 opens from Ely to Norwich, and HS8 opens from Edwalton Junction, Nottingham, to Ely via Peterborough. Services are introduced between Southampton and Norwich, and existing services between Preston / Cardiff and Nottingham are extended through to Norwich (HS3 SP5A, HS5 SP3, HS6 SP2, HS8 SP2A).

WP-12

HS4-4: Cardiff HS – Swansea
HS10-1: Thurlby Junction – Hull
HS11-5: Faversham – Dover Priory
HS12-2: Shenfield North Junction – Norwich

This is the odds and sods work package, the bits left over. On completion, the various SPs are HS4 SP5, HS7 SP4B, HS8 SP2B, HS6/HS10 SP2A, HS11/HS12 SP3.

WP-13

HS2-5: Preston – Carlisle
HS2-6: Carlisle – Riccarton North Junction

This is the extra-highly-speculative extension of HS2 to Scotland.

Scottish

This is trivially straightforward: HS13-1, HS13-2, HS14-1, HS14-2, HS14-3, HS13-3, HS14-4. It will probably have all been completed well in advance of HS3 reaching Edinburgh in WP-9.

Note on Sheffield HS Station

In the main body of the text, I argued for the provision of a CC service to Sheffield Midland station, in addition to the services via South Yorkshire (Meadowhall). I leave the argument as stated, as it is valid in the context. But in practice, with the order of implementation recommended in this appendix, the problem simply disappears. Sheffield gets its full service to its central HS station as soon as HS3's GC-gauge services begin, on completion of WP-8. The only services using Meadowhall are the UHS services to York and Newcastle (the Scottish services also travel this way, but are non-stop). HS7's services use Meadowhall temporarily, but switch to travel via Huddersfield as soon as the route via Ladybower Junction opens.

Sheffield (Midland) already has CC services from the completion of WP-2, of course.