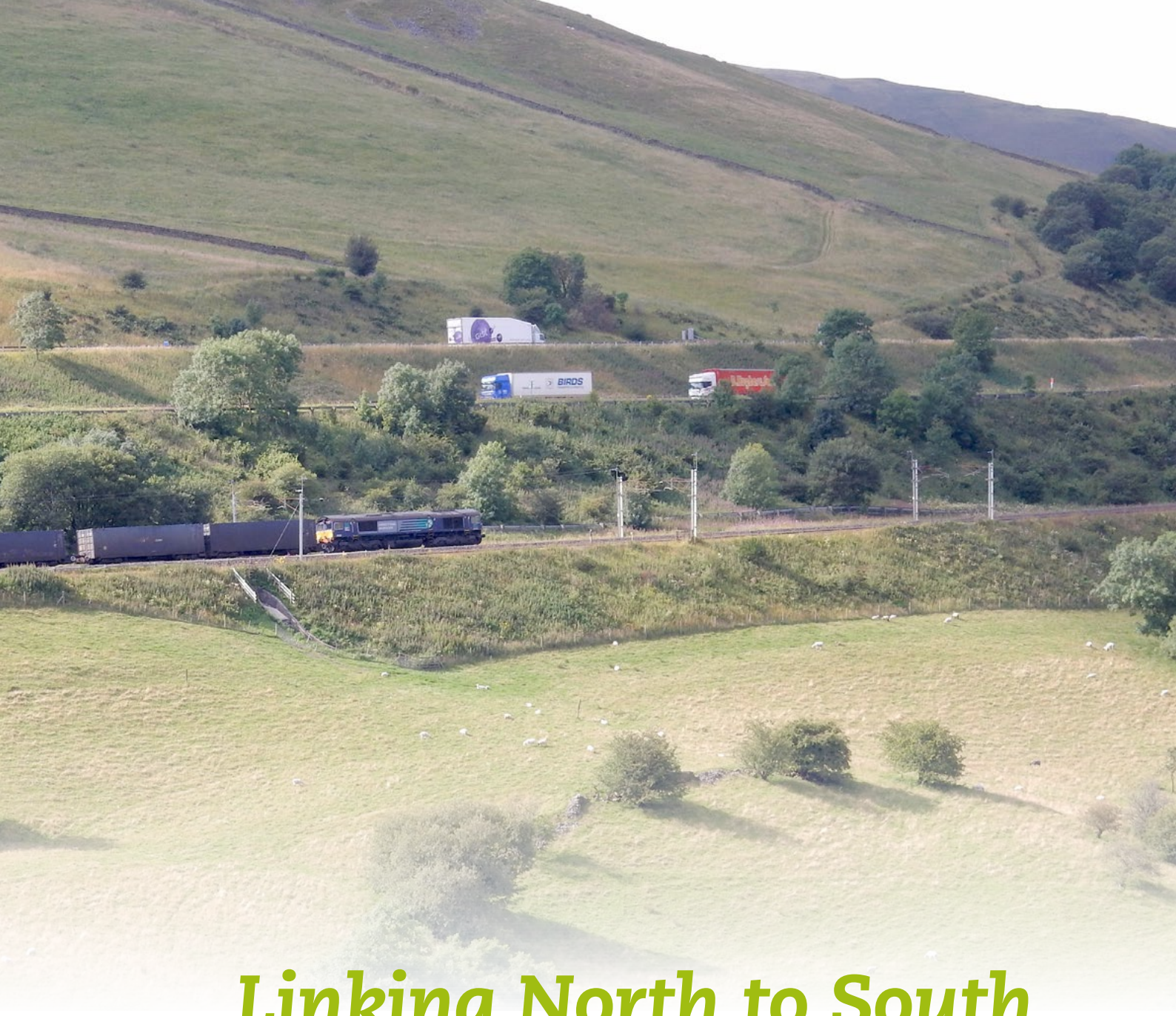

Linking North to South

A review of the HS2 Ltd report

Broad Options for Upgraded and High Speed Railways to the North of England and Scotland

June 2016

GREENGAUGE21

Foreward

The case for a national high-speed rail network has always been about more than shortening journey times. But if anywhere will bring widespread benefits from shorter journey times– including better environmental outcomes – it will be on the 400-mile journey between the Scottish cities of Glasgow & Edinburgh and London.

HS2 plans will go a long way towards achieving the 3-hour journey time target that is generally agreed as being necessary to bring about a large-scale switch from short-haul air travel in this market. But more is needed. In Greengauge 21's view, it is important to be realistic. So we call for a staged development approach that embraces both east and west coast corridors.

This report shows that a 3-hour journey time could be realistically achievable by 2027: the first stage in a longer term programme. Developing plans to reach this target will take much closer collaboration north and south of the border. Transport Scotland and Transport for the North are well-placed to develop the necessary investment programme. The aim of re-balancing the British economy cannot be forgotten. Here is a chance to take a significant step towards achieving it.

GREENGAUGE21

June 2016

Linking North to South: a review of the HS2 Ltd report 'Broad Options for Upgraded and High Speed railways to the North of England and Scotland'

The release of the 'Broad Options' report in March 2016 came with an agreement between Ministers in Westminster and Holyrood to pursue together a goal of a 3 hour rail journey time between London and Glasgow/ Edinburgh. This would exploit the published plans for HS2 – and add further benefits from the investment in HS2 above and beyond those already identified.

This is a great step forward; it opens up the prospect of high-speed rail making further serious inroads into the largest British domestic air market, strengthening high-speed rail's green credentials and its national coverage.

In this report, we take a deeper look at the published document. We recommend the adoption of 2027 as a target date to reach the 3-hour ambition, and we suggest a way forward for the key planning authorities in Scotland and England.

1. Origins and Overview

The March 2016 report is the outcome of work first commissioned by DfT in November 2013[1]. Carried out by HS2 Ltd, it was overseen by DfT, Transport Scotland, Scotland Office, Network Rail and HS2 Ltd.

The aim was to carry out a feasibility study to look at a broad range of options that would address capacity challenges and improve journey times to the North of England and Scotland. The study was to examine improvements to the existing network and partial or full length high-speed lines, including solutions that would achieve a journey time of 3 hours or less between London and Glasgow/Edinburgh.

Previous work by both Greengauge 21 and Network Rail in 2009 revealed a good business case for extending high-speed lines between the North of England and the central belt of Scotland. Transport Scotland commissioned work into the case for high-speed rail between Glasgow and Edinburgh in July 2013, and the results of this work, delayed so that account could be taken of HS2 Ltd's conclusions on north-south high-speed rail, were released alongside the HS2 Ltd study in March 2016.

An initial piece of stakeholder research by Greengauge 21 into the views of North of England stakeholders, identifying support in principle and ambitions for a broadly defined set of connectivity improvements, was conducted and published in November 2012[2].

In May 2015, it was said that there was "no business case" for an extension of HS2 into Scotland[3]. But soon after, at a Greengauge 21 conference held in Glasgow in September 2015, Scottish Parliament Cabinet Secretary for Infrastructure, Keith Brown said he had pressed the company responsible for developing the UK's high-speed rail line to reconsider its earlier conclusions on the case for HS2 to continue north to Glasgow and Edinburgh. He stressed that it was vital that high-speed rail extended north of the Border in order to achieve Scotland-London rail journey times of less than three hours, which he believed was key to encouraging a modal shift from air to rail[4]. We agree: this is one of the key benefits of high-speed rail.

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1. https://www.gov.uk/government/speeches/hs2-ltd-broad-options-report-on-northern-england-and-scotland

2. http://www.greengauge21.net/publications/connecting-hs2-to-scotland-the-north-of-england-criteria/

3. http://www.thenational.scot/news/conference-drive-to-get-high-speed-rail-to-scotland-as-government-and-developers-back-off.6784

4. http://www.heraldscotland.com/news/13644645.Report_on_business_case_for_cross_Border_HS2__quot_in_early_2016_quot_/

In practice, the HS2 Ltd report examines options including those that achieve journey times well below the three hour target set by Scottish Ministers, and these options are described in chapters 3 and 5 (upgrade and new high-speed line respectively).

Ways of delivering a 3-hour journey time target through a new line are described separately in Chapter 4. This appears to be an account of more recent work carried out in summer 2015 that includes use of design speeds lower than those adopted for HS2 further south, but retains the concept of new, separated tracks throughout. The suggested approach in fact still over-delivers, with a journey time outcome of 2h50, even after allowing for time lost dividing trains en route before they continue their journey separately to Glasgow and Edinburgh.

The March 2016 HS2 Ltd report emphasises that it must be regarded as a "**high-level piece of work"** (in respect of benefits); that options were developed "**only at an early stage of design and feasibility assessment**"; and that the report is not seeking "**to assess value for money**". In respect of benefits, the analysis only considers the effects of journey time savings and revenue gains based on HS2 Ltd service plans. The report makes clear that there has been no attempt to assess capacity benefits, or benefits to local and regional services, or (presumably) to freight either[5].

The report cannot therefore be used as a basis for any statement on business case or cost benefit ratios since it has not considered a substantial part of the potential benefits from investment.

5. Broad Options *op cit* §2.4.14

2. Summary of report conclusions

The HS2 Ltd report concluded that:

"Upgrading the existing network on the west, either through an extensive package of interventions using new high speed sections or a new route, could deliver comparable journey time improvements to both Edinburgh and Glasgow, including 3-hour journeys between both cities and London. Upgrades would cost less than a new line and would allow benefits to be delivered in stages, but would not bring the same capacity benefits nor provide the resilience of a new line".

It also noted that if instead investment was made on the east side, only a full new high-speed line could deliver the 3 hour journey time target for both Scottish cities.

The various options considered can be summarised in terms of cost and journey times as set out in the following table.

Table 1: Summary of HS2 Ltd March 2016 report options costs and journey times

Option		Journey times to London		Cost (£bn)	Comment
		Edinburgh	Glasgow		
Upgrade with bypasses west coast		2h58		17–19	Can be delivered in 4 stages
Medium/high speed line west coast		2h50		22–25	New sections of line at 200–350km/h (excludes cost and benefit of Edinburgh – Glasgow high speed line)
Continuous new high speed lines					
West coast	A	2h30	2h30	32–34	
East coast	B	2h30	3h05	27–29+	Excludes cost of Edinburgh – Glasgow high speed line
			3h21	27–29	Assumes Edinburgh Glasgow Improvement Plan (EGIP) is in place (Glasgow Queen Street) with spare capacity
East coast	C	'similar to option B'		28–30	
East coast	D	2h50	2h45	41–43	

Note: costs are quoted at Q2 2011 prices. Optimism Bias levels are 'assessed in terms of whether they can be mitigated'. By way of comparison, HS2 Phase 1 & 2 costs are now updated to 2015 prices and total £55.7bn

In the table, it can be seen that the west coast upgrade approach, which comprises a four stage programme of bypasses, only some of which are at high-speed, achieves the 3 hour target (without any reliance on time savings achievable north of Carstairs) and costs £17–19bn. The report explains that the bypasses could subsequently be linked up to form a full new route. And of course, other combinations of schemes along the line of route and other staging approaches would be possible.

The medium/high speed line alternative was developed as a revision of the full high-speed line specification for the west coast (Option A in the report). It follows the topography more closely, in some cases at the cost of reduced operating speeds, but saves on some tunnelling. It was priced at £22–25bn, and as noted, it slightly over-achieves, with a 2h50 minute timing. This is a 48–49 minute time saving for the two cities against the HS2 Phase 2 business case draft timetable (which is taken as a base throughout the report).

If a full-specification high-speed line was built on the west coast (Option A), this was estimated to add a further £10bn[6] cost and save a further 20 minutes.

Three options were considered for the east coast. Options B and C differed in alignment choices (B cuts off the corner to Edinburgh through the Lammermuir Hills) while C stayed closer to the east coast; Option D fashions a new route from Newcastle to Glasgow through the Southern Uplands, with a spur to Edinburgh. Only Option D of those on the eastern side achieves the 3-hour target for both cities but, with a need to cross hilly terrain, comes at a higher cost (£41–43bn).

6. But it is unclear from the report whether the Option A cost includes the provision of high-speed routes from Carstairs towards central Glasgow and Edinburgh that would be shared with Edinburgh – Glasgow high-speed trains; if this is included, the cost differential would be significantly less than £10bn

3. Discussion of key issues

The report points towards following a west coast approach to achieve a 3 hour London journey time for both Edinburgh and Glasgow. While much more work is needed, and capacity considerations and phasing would be key factors, a programme of bypasses on the west coast corridor that can later be linked together achieves the target journey times for both cities and is significantly less expensive than a continuous new line – even one adapted with lower speeds to better fit with the corridor topography.

East coast options can match the west coast Edinburgh time but not Glasgow except at high cost. But the report suggests that journey times (and line capacity) on the east coast will also need attention in any event and emphasises the common value to be gained for Anglo-Scottish travel and for journeys between Scotland and Newcastle and other north England cities by improving the east coast route.

There is no suitable single '**central route**' option: the west and east coasts serve specific markets.

These are each valuable conclusions. But there are several key issues in taking forward the further work needed to develop the preferred approach and its business case:

- The need to set the parameters – including timescales – for what will very likely be a phased approach, comprising upgrades and some new line (bypass) construction in the west coast corridor leading to/leaving open the potential for a full high-speed line in the longer term;

- The need to plan for the investment that will be needed on both east and west coast routes in any event, to meet growing traffic demands and service improvements including those committed in the recently awarded Trans Pennine express franchise;

- The need to consider how best to specify HS2 services; and to meet the needs of the railfreight sector;

- The need to develop integrated solutions within Scotland that address domestic as well as cross border demand and likewise, in Northern England, to develop approaches that accommodate the objectives set for the 'Northern Powerhouse' (covering both east and west coast corridors).

There is much for the planning authorities – DfT, Transport Scotland (TS) and Transport for the North (TfN) – to address here. But it would be helpful – and arguably necessary – to have a clearly stated aim. Our suggestion is that **a horizon of 2027 is adopted as a design year for delivery of the 3 hour target journey time** (for reasons explained below) while recognising that:

- The approach adopted should allow for further enhancement: that is, developed and judged on its own merits, but capable of accommodating longer term improvements without damage to the '2027' business case;

- Since this will be a west coast approach if Edinburgh and Glasgow are to gain equally, TS and TfN should also jointly examine the case for investment on the east coast corridor over a similar timeframe. As part of this work, a matrix of '2 × 5' journey time and service level targets should be established between Edinburgh and Glasgow and the 5 core cities in the North (Leeds, Liverpool, Manchester, Newcastle and Sheffield). TS may well wish to extend this approach to include cities in Scotland north of the central belt.

The thinking behind the 3 hours in 2027 target for London to Glasgow and Edinburgh is that:

- In 2027, HS2 will have reached Crewe. This will bring a 48 minute journey time saving for Glasgow[7] – and could do the same for Edinburgh;

- While there would be further journey time savings (5 minutes) from the expected extension from Crewe to Golborne (south of Wigan) in 2033, an 11-year timescale from now should be sufficient time to achieve the incremental improvements needed in the west coast corridor and in central Scotland;

- At current rates of demand growth, additional capacity is going to be needed on the west coast corridor by the mid-2020s in any event. The costs of a three hour solution therefore need to be considered as an increment over and above the expenditure needed for capacity/performance reasons alone, rather than as a stand-alone cost;

- The post-HS2 service plan for the northern part of the west coast can be improved from that set out in current appraisal assumptions, with reduced journey times, even before any route upgrades are considered.

Before expanding on the third and fourth points above, it is worth considering the March 2016 report in more detail.

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7. https://www.gov.uk/government/news/hs2-route-from-birmingham-to-crewe-to-open-6-years-early-chancellor-confirms

4. Report review: detailed points

Existing Network (chapter 1)

The report makes a number of relevant observations, noting that both west and east coast routes over their northern sections are heavily used:

- **Preston station**. Network Rail is developing plans for an upgrade that could include platforms of 400m length. This influenced the upgrade options developed later in the report, since it means a via Preston option has added advantages over a bypass (once considered in the first HS2 Ltd Phase 2 work) in that full-length HS2 trains would be able to call at Preston;

- **Shap/Beattock summits**. It is said that the climb(s) from the south take 30 minutes for diesel hauled freight; 15 minutes for electrically hauled freight and 6 minutes for passenger trains. Although the HS2 Ltd report doesn't say so in terms, there are no suitable freight loops available, and it notes there are aspirations to run more inter-modal freight services over this route;

- **Carlisle station**. An opportunity to lift the current 30km/h speed limit for non-stopping trains in Control Periods 6/7 (that is 2019 – 2029) is noted, but current plans would still leave a restriction of perhaps 70 km/h. (Later, in chapter 3, it also notes that improvements could allow for 400m platforms for full-length HS2 trains, and Carlisle is recognised as being a better location to divide/join trains than Carstairs, the previous HS2 Ltd assumption – although Preston is the now preferred joining/dividing location);

- **Carstairs – Glasgow**. Here the report suggests the route suffers from significant congestion – as has been noted separately by Network Rail – with eight flat junctions in less than 30 miles. This makes this section of line a prime candidate for new tracks, probably in the form of a bypass;

- **East Coast**. It points to a number of speed restrictions due to curves (York 50 km/h; Durham area (120km/h); Newcastle station (50 km/h); Morpeth (80 km/h) and Berwick (80km/h).

The northern approach to Carlisle station, WCML (photo: Greengauge 21)

Appraisal of demand and benefits (chapter 2)

In terms of markets to be served, the report notes that Preston would be a key point to serve, with a suggestion that as much as a third of the journey time benefits from the 3 hour option would be lost if the Preston stop is omitted. While there would no doubt be a high level of interchange at Preston, it would seem unlikely to be this high in practice because services such as those from Edinburgh/Glasgow to Manchester, Birmingham (and in a few years' time, Liverpool) would also benefit from the route speed up. This seems to have been overlooked in the HS2 Ltd analysis to date (one of the reasons why benefits have so far been understated).

On the east coast, the HS2 Ltd report notes that 'a (cross-border) high-speed route in the East could allow the proposed Phase2 London to Newcastle services to be extended to Edinburgh'. But of course, the planned HS2 services to Newcastle could be extended to Edinburgh over the existing route too. Either way, this may represent a good post-2033 approach to achieving a London - Edinburgh 3 hour journey time.

Options for upgrading the existing line (chapter 3)

Packages of upgrades were restricted to those achievable within the confines of the (railway-owned property) boundary. Unsurprisingly since the lines in question were not built (as was often the case further south) with added width of land-take alignments as 4-track railways, the scope for speed increases (broadly by straightening 2-track alignments) was limited to at best operating speed gains of +24km/h. This yielded aggregate journey time savings of only 15 minutes on the west coast and even less on the east. Costs are said to be a somewhat astonishing £15bn – a figure likely to have been inflated by a presumption of major compensating costs to reflect disruption to the railway.

So there appears to be a weakness in the range of options considered since in some cases limited property acquisition beyond the railway boundary might allow more cost-effective improvements, and these will not have been considered. The example of the 4-tracking scheme along the Trent Valley built as part of the West Coast Route Modernisation in the last decade was generally regarded as a success and itself was implemented without major disruption, some of it carried out within railway owned land, some of it not. The conclusion to ignore upgrades and only consider bypasses in this option appears to have been reached prematurely. It's an optimised combination that is required.

With attention turned to bypasses, HS2 Ltd concluded that a whopping 220km of new route would be needed to achieve the 3 hour journey time for both Edinburgh and Glasgow – this is approximately two thirds of the route length on the west coast – and would cost £17-19bn. Equivalent approaches on the east coast would result in 154km of bypasses at £11-13bn or 175km of bypasses at £14-16bn or, in a third package focussed on south of Newcastle, costing £18-20bn (219km long), but none of these east coast approaches would achieve a 3 hour Glasgow journey time.

For the Shap and Beattock sections (and specifically their northbound climbing sections), loops (both static and dynamic) were considered along with the innovative idea of 'crawler lanes'; bypasses and a solution that in effect restricted freight to night time periods were also noted. Options to divert freight, for instance on to the parallel Glasgow and South Western route, were not considered[8]. Static freight loops were ruled out (understandably, since the capacity limitations of highly divergent run times would remain), but no comment is made on the long loop options.

8. The G&SW route provides an effective bypass for the Carlisle – Glasgow route, including Beattock. It is a longer route and will not necessarily be welcomed by freight train operating companies. Investment would be needed to provide unconflicted access to freight terminals in the Coatbridge area – and this might form part of an updated investigation into the parallel need to create a better route into Glasgow for fast passenger services from Carstairs.

In the report, the choice between a crawler lane solution and a bypass is seen as one between disruptive build of an immediately adjacent third track and a bypass built 'off line'. This is too simplistic. If disruption is a major factor, a crawler lane – that is adding a third track – could equally well be built 'off line'. Moreover, it could turn out to be best to build such a new track for higher-speed passenger trains able to surmount steeper grades but which need gentler horizontal curves, leaving the existing uphill grades for freight. It would however cost a lot less than a new double track line. Since a high-speed bypass is estimated to save only 15 seconds, the best value for money option – a crawler lane (or new fast line) built in a disruption-minimised way, as 'off-line' as needed, has potentially been overlooked.

Within Scotland, the study assumes that investment will have been made at Carstairs to lift a speed restriction for Edinburgh trains from the south from 25 km/h to a (still disappointing) 65km/h – again it would seem, no consideration having been given to a better route beyond today's railway boundary fence, precluding possibly the best mid-range scheme. North of Carstairs, HS2 Ltd's work defers to Transport Scotland's, but ignores the time savings it would bring, which would be worth around 15 minutes. The report notes that Edinburgh can accommodate 400m long trains but Glasgow Central could not and that at both some capacity work would be needed. Clearly, the plans in Scotland and England now need to be joined up.

The chapter provides helpful summaries of the time savings deliverable by the various bypass options. In putting together possible packages, the report is mindful of the need to consider capacity questions as well. But there is no discussion of train control and train management systems ('the digital railway') and timetable re-shaping and the contributions these developments could bring. The report falls a long way short of having identified a plausible upgrade package as a next or interim step of the type needed by 2027.

Delivering a high speed route to Scotland (Chapter 4)

In essence, this chapter describes an attempt to adapt the previously identified continuous high-speed line in the west coast corridor described in Chapter 5 and termed Option A. The aim was to reduce cost and yet still achieve the three hour target. At some points, line speed was reduced (for instance "between" the Lakes and Yorkshire Dales National Parks[9], to 200-230km/h). The route remains continuous new-build (possibly apart from at Preston) and extends from the HS2 Phase 2 northern limit at Golborne in Lancashire as far as an assumed mid-point of a new Edinburgh – Glasgow high-speed line in the central belt of Scotland. All new infrastructure costed by HS2

9. These are due to coalesce in August 2016; currently the M6 and the West Coast Main Line pass between them in a narrow corridor.

Ltd has been assumed to be built at the larger UIC-Gauge – a useful accommodation for the longer term, but of course more expensive, and of no benefit until a fully gauge-expanded route is complete.

It appears that the route would run through Preston and bypass Carlisle to the east.

Other options for continuous high speed routes (Chapter 5)

Unlike the chapter 4 route, here the options are designed to achieve 400km/h throughout. Since the assumed route from the city outskirts to the city centres of both Edinburgh and Glasgow entails use of the existing railway, these options would rely (as would all others considered in the report) on the deployment of classic compatible rolling stock.

Overall Implications

In reviewing the report in detail, some important, if tentative, conclusions can be drawn:

- The cost base needs to be updated to 2015 prices;
- None of the options considered have low capital costs ;
- While a full high-speed line would achieve journey times of around 2h20 – 2h30, the range of options examined generally achieve sub 3-hour timings while ignoring time savings achievable within Scotland (specifically, north of Abington);
- All options assume use of classic compatible trains – although they have been costed to accommodate UIC-Gauge trains in the longer term;
- The best approaches at both Preston and Carlisle – at least for the medium term – would entail upgrades at these stations, including for full length HS2 trains, and to ease speed restrictions. Then there is no need to contemplate building an HS2 station at Carstairs;
- While it has to be recognised, in fairness, that this was a preliminary study, some lower cost (and potentially more cost efficient) solutions to the aim of getting journey times down to three hours appear to have been prematurely rejected and these include investments in new lines/tracks needed for capacity reasons within Scotland that would bring performance and speed gains; 'crawler lanes' or the use of parallel routes for freight past Beattock and Shap; local upgrades (junction and alignment improvements) that may well be needed in any event; new lines/tracks

that entail using land beyond the existing railway boundary; applications of digital railway technology; and train service operating philosophy, including dividing/joining trains – as discussed below;

- On the East Coast, it would be possible to extend planned HS2 Newcastle services to Edinburgh. Journey times would be reduced if investment is made to overcome the speed profile 'dips' at locations such as Morpeth;

- In Scotland, careful consideration needs to be given to factors that may not have been fully covered in the Edinburgh – Glasgow high-speed study, including questions of capacity and connectivity to locations such as Edinburgh Airport and the main routes northwards from the central belt to Stirling, Perth, Dundee, Aberdeen and Inverness. With shorter journey times across the border, the value in connecting these cities directly to the major cities of northern and midland England is stronger (linkages such as Aberdeen – Manchester and Birmingham – Inverness), but has so far been ignored[10].

10. Whether there remains a case for a full high-speed-line between Edinburgh and Glasgow with connections from both cities southwards to the West Coast Main Line will depend on joint consideration of east and west coast corridor options. It may be, for example, that a new HSR line between the west coast (Carstairs area) and Glasgow (a route where capacity is at premium) could be combined with an upgrade to the Carstairs – Edinburgh route (which is a faster line already and is relatively lightly used). But either way, investment at both Glasgow and Edinburgh city centre stations is likely to be inescapable.

5. Service assumptions and parameters

The service assumptions – both for HS2 and for other 'classic' line services – were set several years ago for project appraisal purposes[11]. They show an hourly HS2 Glasgow-London train in Phase 1 (2026) and a twice hourly combined Glasgow/Edinburgh-London HS2 train in Phase 2 (2033) – dividing and joining at Carstairs – and an alternate hours Glasgow/Edinburgh-Birmingham HS2 train is also provided. The latter makes all the usual west coast intermediate station calls, but in Phase 2, London passengers from Carlisle, Penrith, Oxenholme and Lancaster are expected to travel on a conventional train diverted via Manchester (or change at Preston). We have already noted that in the new study, HS2 Ltd has switched the divide and join operation from Carstairs to Preston (or possibly Carlisle) which will therefore gain a direct HS2 service to London. If trains divide/join at Preston, it should become possible to serve Lancaster, Oxenholme and Penrith by London HS2 services as well.

Carstairs (photo: Greengauge 21)

On the east coast, from 2033, Newcastle has a twice hourly London HS2 service and also a service to Birmingham.

11. See for example the PFM Assumptions report of October 2013 http://assets.hs2.org.uk/sites/default/files/inserts/S%26A%2020_PFM%20assumptions%20report.pdf

Photo courtesy Hitachi Rail Europe

But as demand has grown strongly in the interim, these service plan assumptions (and they are no more than that; there has to be a consistent specification from which to estimate project benefits) are starting to look inadequate. Electrified and faster services have already been introduced between Manchester and Glasgow/Edinburgh. Network Rail will already be planning for the new services to be introduced between Liverpool and Scotland and the extension of the Trans Pennine Express services northwards from Newcastle to Edinburgh. With new 200km/h train sets now confirmed, each of these services will be much faster than today's and demand will grow even more strongly. On the London-Scotland routes, the franchised rail company (Virgin Trains East Coast) is determined to use its new *Azuma* train fleet to speed up services and to win more market share from the airlines, and in May this year, First Group won access rights to operate a competing Edinburgh – London Kings Cross service.

The first requirement is to undertake a detailed study of how cross-border demand and services might evolve over the years to 2027. This is likely to show a much more intensive service plan with higher demand levels than is used in the 'cautious' assumption-set in the project appraisal and is also likely to represent a more likely outcome, especially if Transport for the North is to fulfil its agenda with the 'Northern Powerhouse'.

At the same time, an examination of how railfreight might develop is needed. This should nest into Transport Scotland's new strategy for railfreight. In consultation with the freight operating companies and the ORR, the way in which a switch to electric traction and/or a switch to use of the route via Dumfries in Scotland might be achieved needs to be examined, given its significance to route capacity issues. This work might

Freight using the WCML and the M6 through the Lune Gorge (photo: Greengauge 21)

also lead to some suitable full length (possibly dynamic) freight loops being provided before 2027 and this will need to be considered against the likely alternative of sections of three/four-tracking and bypasses.

As HS2 is extended northwards – by upgrades, bypasses, new lines, or indeed by service extension over the existing railway – it is appropriate to look more closely at the service and fleet rolling stock parameters and how these might best be defined in practice rather than as analytical assumptions for use in scheme appraisals.

Two operational choices are of wide relevance. The first is the notion of dividing/joining trains. At the price of an assumed 5 minute penalty for train division, the advantage of doubling service frequency (as provided in HS2 Phase 2 for London - Scotland) might look good in appraisal terms. But the time penalty will probably average closer to 10 minutes on the (southbound) joining journey, and inevitably these procedures add to the risk of late running and diminished performance reliability. These real world factors need to be considered carefully. It may be better in practice to plan on full length trains running at hourly intervals that don't need to divide/join en route.

If additional capacity is needed there are at least two options to consider. One is to use the two spare paths that were set aside in Phase 2 for Heathrow trains (the Heathrow connection has now been dropped and airport passengers from Scotland will instead travel via Old Oak Common where all HS2 trains will stop). The other is to extend either or both hourly London-Newcastle HS2 services to Edinburgh – and this option might suggest that the existing, lightly used and generally fast line from Carstairs

to Edinburgh should be the subject of upgrade (and possibly provided with a new connection to the new Edinburgh Gateway station as well as the city centre), rather than replacement with a new high-speed line.

The second question is about tilt. It has been estimated that the availability of tilt north of Crewe could save about 15 minutes on journeys compared with non-tilt (200km/h services). It is as yet unknown whether a train design equipped with tilt for use north of Crewe could comply with the technical requirements for operation over HS2 infrastructure. But the use of a series of bypasses and the need to adopt lower line speeds to fit the topography of northern England and southern Scotland suggest that tilt could be of relevance to achieving the three hour journey time target. The question is whether such a capability could be fitted to a train capable of meeting HS2 Ltd technical operating specifications – for instance on meeting track force limitations.

In the context of seeking to achieve the 3-hour journey time target (which in a post-HS2 Phase 2a world means a need for a journey time reduction in 2027 of 43 minutes) changes in these two areas alone could be worth 25 minutes. But they would not, of course, address the capacity problems that are such a central part of the challenge ahead and indeed they may add to the capacity challenges while bringing journey time savings. On their own, they would not allow the achievement of the 3 hour journey time target. For this, bypasses will certainly be needed, but local upgrades, separate freight routes, electric traction for freight and crawler lanes should be considered too.

However, the speed-up needed from bypasses etc could be significantly reduced, and costs reduced substantially from the illustrative case reported by HS2 Ltd to achieve a three-hour journey time in the proposed target year of 2027. This is especially the case since the priority area for attention to capacity needs appears to be north of Carstairs into Glasgow and valuable time savings should be deliverable from what is likely to be an inescapable and significant investment. (The bypasses table in the Report only considers the route south of Carstairs.) Business cases for higher-speed operation nearly always rest on meeting a capacity need in the first instance.

'North of Crewe' could be a prime candidate to prioritise application of the digital railway; HS2 trains at least will be equipped with ETCS Level 2, capable of operation with in-cab signalling, and its application across the border could help mitigate performance risk on HS2 itself.

With 'crawler lanes' for Beattock and Shap, station investment at the key stations at Carlisle and Preston and junction improvements to improve capacity in England, it would seem quite possible that the length of new bypasses identified in the £17-19bn 'upgrade with bypasses' package could be much reduced while still achieving the 3 hour journey time target in 2027.

6. Conclusions

The Broad Options for upgraded and high speed railways to the North of England and Scotland provides strong evidence on how a 3 hour journey time between London and both Edinburgh and Glasgow can be achieved.

There are implications for both east and west coast corridors. To get the best solutions for both the east and west coast corridors, **we recommend that Transport Scotland and Transport for the North work together since their interests overlap to a considerable extent**. While investment must be made on the west coast if the three hour target is to be fully achieved in a reasonable timescale and cost budget, the east coast offers a way to add long distance high-speed capacity and improve connectivity between key cities in the North of England, and improve cross-border links, by the simple expedient of extending London-Newcastle HS2 trains to Edinburgh from 2033.

The likely market demand trends in both east and west coast corridors over the years to 2027, (passenger and freight) taking into account committed growth plans in franchises should be examined. Franchise commitments and approved 'open access' passenger service applications should form the starting point for a central case. Standard industry growth rates can be used to provide a downside sensitivity case.

Draft service plans for 2025 and 2027 can then be developed in conjunction with industry service providers and key corridor stakeholders to meet the identified demand levels and patterns taking into account (but not restricted to) franchise commitments, and with options for HS2 services for the 2027 case.

While concentrating on a 2027 plan, it is vital that account is taken of longer term potential, especially from the full HS2 Phase 2 investment. An outline plan for 2033 and 2043 is needed too if potentially abortive expenditure is to be avoided.

Options within Scotland need to be worked up fully, including addressing station capacity questions in central Glasgow and Edinburgh.

For the west coast, **we have a firm recommendation to adopt 2027 (when HS2 should reach Crewe) as a target date for achieving a 3 hour connection to London for both Edinburgh and Glasgow**.

The HS2 Ltd report has exposed how difficult it is to develop, compare and contrast smaller-scale improvements with the greater benefits of larger bypass and new line approaches. Several parties have a stake in this and need to be involved (DfT, Transport Scotland, Transport for the North, Network Rail, the National Infrastructure Commission and HS2 Ltd). To ensure that progress is accelerated (the recent report was initiated three years ago), **it is recommended that a new single-purpose company is established to refine the programme needed** to deliver client aims on capacity, connectivity and performance for all rail services on the northern section of the West Coast corridor for implementation by 2027. It should be accountable jointly to Scottish and UK Government Ministers. Its sponsors should be Transport Scotland and Transport for the North.