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Potential Benefits of High Speed Rail Services to Scotland

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Introduction
Scotland's situation, as a relatively small nation on the periphery of the much larger EU trading bloc, makes good communications essential. Over recent years, the existing road and rail surface transport systems (variously congested, slow and poorly connected) have proved inadequate to deliver the improved and wider connectivity that Scotland now requires. Instead, an intricate network of air routes has developed, to become the dominant mode of communication from Scotland across the British mainland, and to continental Europe.

This paper aims to demonstrate that a properly configured UK high speed rail system would deliver a step change in connectivity from Scotland to all principal UK destinations, and viable onward routeings to near Europe. From this, major economic benefits, and environmental benefits also, would accrue; with most domestic air routes effectively rendered redundant, major reductions in CO_2 emissions, and in national dependency on imported oil, would result.

Scotland's Current Transport Links
As already noted, aviation is now the principal public transport mode for Anglo-Scottish journeys, with the air:rail modal split on London - Scotland journeys standing at around 90%:10%. London's five airports are by far the predominant destinations, collectively accounting for between a quarter and a third of the Scottish airports' departures (see Figure 1). A similar proportion of flights serves a variety of English provincial and Irish destinations, with around 10 per day to Manchester and Birmingham, and 5 per day to other cities (the omission of a city as large as Liverpool is puzzling). Even the highest level of service (13 daily flights from Edinburgh to Manchester) includes gaps of up to 3 hours.

Of the remaining flights (variously to island, European, intercontinental and holiday destinations) those to Paris CDG, Amsterdam and Frankfurt are particularly noteworthy as providing links to a wider network of long-haul flights.

Figure 1 : Existing Anglo-Scottish Connectivity – by Air

Flights per day from principal Scottish airports	London	Manchester	Birmingham	Newcastle	Durham Tees	Leeds/Bradford	Liverpool	East Midlands	Norwich	Cardiff	Bristol	Southampton	Belfast	Dublin	Stavanger	Copenhagen	Paris CDG	Amsterdam	Frankfurt
Aberdeen	**19**	**7**	**4**	**6**	**4**	**3**	**0**	**3**	**6**	**0**	**3**	**4**	**1**	**1**	**8**	**2**	**3**	**4**	**0**
Edinburgh	**56**	**13**	**8**	**0**	**0**	**3**	**0**	**3**	**2**	**5**	**3**	**6**	**7**	**4**	**0**	**4**	**5**	**5**	**5**
Glasgow	**40**	**8**	**10**	**0**	**0**	**3**	**0**	**3**	**6**	**3**	**3**	**5**	**7**	**2**	**0**	**1**	**3**	**5**	**0**

As the recent Eddington Study has demonstrated, good transport connectivity and economic prosperity go hand-in-hand. The above table could be taken as summarising the short-haul connectivity on which Scotland's continued prosperity depends.

With the environmental concerns that surround aviation, its inherent high energy use, and uncertainties as to the price / security of future oil supplies, it would be desirable if railways (with a carbon footprint perhaps one fifth of aviation, and better still if electrified) could play a greater role in Scotland's connections to England, and to Europe.

However, the remoteness of Scotland's principal cities from most UK conurbations, and the slow speed of the connecting rail routes (often requiring a time-consuming change of trains) have so far rendered this aim impracticable. Although main line routes conventionally offer hourly, or at worst 2-hourly services, journey times are mostly well in excess of the rail/air crossover point of around 3 to 3½ hours. This is the city-to-city journey time above which flying becomes a preferable alternative to rail, a factor amply reinforced by the perception (not necessarily reality) of more expensive rail fares.

Figure 2 : Existing Anglo-Scottish Connectivity – by Rail

Journey* Time / **No of daily direct trains**	London	Manchester	B'ham #	Newcastle	Leeds	Liverpool	Leicester	Cardiff	Bristol #	So'ton #	Paris	Am'dam
Edinburgh	**4¼**	**3½**	**4**	**1½**	**3**	**4**	**5½**	**7**	**5¾**	**6½**	**7½**	**9½**
	18	**4**	**19**	**34**	**13**	**0**	**0**	**0**	**9**	**0**	**0**	**0**
Glasgow	**5**	**3½**	**4**	**2¾**	**4**	**4**	**5½**	**7**	**5¾**	**6½**	**8**	**10**
	17	**3**	**8**	**11**	**2**	**0**	**0**	**0**	**2**	**0**	**0**	**0**

Quoted times via West Coast Main Line (WCML) - ECML route approx 1 hour longer – and note current proposals to terminate Scottish CrossCountry (via WCML) trains at Birmingham.
* Estimated time including single change of trains, where no direct journey exists.

The above table demonstrates clearly that despite rail offering service levels and through-the-day frequencies at least comparable to aviation on many routes (especially if change of trains is allowed), it is the journey time (associated with pricing issues) that is the major determinant on people's choice between flying or taking the train.

A third dimension must be considered – that of people choosing to drive, rather than use public transport. This decision is determined by a huge range of issues, including perceived cost, personal space/freedom, transport of luggage, places to call en route. But with many car journeys from southern Scotland to Lancashire and the West Midlands taking perhaps 4-5 hours door-to-door, there would appear to be little incentive to use the poor public transport links currently on offer.

The High Speed Rail Solution

It seems evident that if rail's inherent superior frequency of travel could be complemented by a step-change improvement in journey time, to make 3-4 hours the norm for all principal UK intercity journeys, then rail would become the mode of choice for these journeys. Assuming that pricing can be made competitive with other modes, people will respond positively to the improved journey experience and environmental performance. This is the logic behind high speed rail.

However, development of high speed rail solutions to date has concentrated on provision of London-centric radial systems, usually replicating existing East Coast or West Coast Main Lines (ECML & WCML). A perceived need to achieve direct high speed rail access to Heathrow has proved a major distraction - note recent Greengauge21 and Arup proposals. Little attention has so far been devoted to developing a holistic solution that will address transport needs across the entire UK, in creating a genuine high speed intercity network.

High Speed North
This is the proposal put forward by the 2M Group of London Councils, as an alternative and superior transport solution to eliminate any requirement for a third runway at Heathrow Airport. The underlying logic is that with 28% of Heathrow's flights to destinations potentially within 4 hours range of London by high speed rail, the third runway becomes unnecessary – if the correct rail links are put in place. For this, the following become essential:

- A high speed rail link from London to Scotland to capture intercity flows.
- High quality connections to Heathrow to provide an alternative to connecting flights from UK satellite airports.
- Improved links to the developing European high speed network, and secure operation of the Channel Tunnel without further disruption from fires etc.

High Speed North differs from other high speed rail schemes in that it recognises the basic impracticality of building high speed lines into the constricted environment of Heathrow. Instead, it concentrates on addressing the wider issue of poor surface access by the development of the currently uni-axial Heathrow Express system into a 'Compass Point' network, with additional main line links to south, west and north. The northern arm would take an orbital track, linking to all existing main lines and (at Cricklewood) to the new high speed line. With a 20 minute journey time, and a frequency of perhaps 10 trains per hour, it is no longer necessary to bring the high speed line to Heathrow – instead, Heathrow is effectively brought to the high speed line.

The high speed line to the north would be configured as a single spine, aligned with existing transportation corridors for minimum environmental impact, and minimum controversy. The main route, developing incrementally, would follow the M1 corridor as far as Yorkshire, and then the ECML as far as Tyneside. Two west-facing spurs are proposed – the first, following the M6 corridor into Birmingham, and the second, following the Woodhead corridor to Manchester, and onwards to Liverpool.

In all cases, the high speed line would call either at existing city centre terminals, or at suburban stations (eg Meadowhall at Sheffield) well connected to the city centre by frequent local train services and trams.

The proposed 'spine and spur' configuration unites WCML, ECML and also Midland flows and allows connections from northern conurbations to London for minimised total route length. Additionally, the north-facing connection from Birmingham facilitates Cross-Country flows, and likewise Transpennine flows from the Manchester/Liverpool spur. Hence a network is created, covering all of the principal UK main line axes (with the single exception of Great Western) and offering major capacity relief.

Figure 3 : Proposed Anglo-Scottish Connectivity – by High Speed North

Journey Time / Frequency (H, ½H, ¼H, Ch=change)		London	Manchester	B'ham	Newcastle	Leeds	Liverpool	Leicester	Cardiff	Bristol	So'ton	Paris	Am'dam
Edinburgh	Journey Time	2¼	2	2	¾	1½	2½	1¾	4¼	3½	4¼	4½	5½
	Frequency	¼H	½H	½H	½H	½H	½H	H	H/Ch	H	H/Ch	2H	2H
Glasgow	Journey Time	2¾	2½	2½	1¼	2	3	2¼	4¾	4	4¾	5	6
	Frequency	⅓H	H	H	½H	H	H	H	H/Ch	H	H/Ch	2H	2H

A comparison with Figure 2 amply demonstrates benefits accruing from the improved connectivity offered by High Speed North.

High Speed North within Scotland (see Figure 4).
An 'East Coast' route to Scotland has been selected on account of the network efficiencies already described, and the north-south orientation of east side conurbations (Leicester, Nottingham/Derby, South Yorkshire, West Yorkshire and the North-East, as opposed to the east-west orientation of Manchester and Liverpool. Additionally, an east-sided approach into Scotland places Edinburgh and Glasgow on the same route. This establishes further justification for the desired high speed link between the two cities, and avoids the 'Carstairs split' which is inevitable in a west-sided approach.

By combining Glasgow and Edinburgh passengers onto a single train, service frequencies and load factors – essential for minimising CO_2 per passenger kilometre, a key environmental measure – can be optimised.

With the existing railway between Newcastle and Edinburgh poorly-aligned, and no motorway to provide an alternative corridor, routeing through the Borders region becomes more difficult. An A1/ECML route appears to offer no particular advantages, being somewhat circuitous and with difficult topography north of Berwick. Hence a more direct route, via Wooler, Coldstream and Lauderdale, is preferred.

Issues of a new railway intruding into a largely rural and undeveloped environment (albeit largely following the A697/A68 corridor) are recognised. Aside from the normal environmental mitigations, this can be best addressed by incorporating gains for the local community. With a short extension of the proposed Waverley line restoration, onwards from Galashiels through Melrose and Earlston (all along existing trackbeds) to join the new line near Greenlaw, a new Waverley Route can be created, with additional stations at Wooler and Alnwick, joining the ECML at Alnmouth.

The benefits of high speed rail can only be fully realised if good interface can be achieved with the existing Scottish rail network, focussed on city centre stations. The only practicable option for an Edinburgh terminal appears to be the existing Waverley Station, which will allow maximum connection possibilities with existing public transport. Through platforms here have the necessary 400m length compatible with standard European 'TGV' operation. New tunnels to east and west of the station will be required.

The onward route to Glasgow is envisaged as following the M8 corridor, and entering the city via the Whifflet branch and Rutherglen; an extension of Glasgow Central Station across the Clyde bridge (to achieve the necessary 400m platform length) would provide the desired city centre terminal, again with optimised public transport interface.

Associated Benefits for Railfreight

With a new high speed line becoming the principal conduit for express passenger traffic into Scotland, the existing main lines are freed up to concentrate on slower speed freight and semi-fast passenger services. With the reduction in speed differentials, there are disproportionate gains in line capacity. This is particularly important on the WCML, which is the only north-south route currently cleared for W10 container traffic (ie 9'6" containers on standard flat wagons). This will allow further environmental gains from the transfer of freight from road to rail, allowed by the increased capacity and greater availability of W10-cleared routes.

Improvements in Northern Scotland

It seems essential that a high speed rail solution for Scotland is extended north of the Forth-Clyde line. Cities such as Inverness, Aberdeen and Dundee (with journey times to Edinburgh and Glasgow of 3½, 2½ and 1½ hours respectively) would benefit hugely from improved connectivity within Scotland, as well as to England and Europe. Of the three Northern cities, Aberdeen assumes the greatest importance, on account of its greater population, its status as a regional centre, and the flights from its airport capable of conversion to rail.

Accordingly, a further proposal is advanced, to re-establish the abandoned direct Edinburgh-Perth route via Glenfarg, and the Strathmore route via Forfar towards Aberdeen. Alignment issues through Fife will restrict the southern section of new route to perhaps a maximum of 200kph; but with the straight alignment of the Strathmore route, full 'high speed' of 300kph appears practicable. With such a route, Aberdeen-Edinburgh timings could be halved, and there would be savings of almost 1 hour for Inverness, and ½ hour for Dundee.

Proposed Technology

The requirement for interoperability with existing European high speed rail systems – essential for the establishment of through communications to Europe from Northern and Scottish cities as the low-carbon alternative to flying – means that there is no practicable alternative to existing 'steel wheel on steel rail' technology.

An associated advantage is that incremental development is possible; for instance, the first phase of development of High Speed North, from London to Birmingham and Leicester, would allow Eurostar trains (presumed available owing to displacement from Channel Tunnel operations by higher capacity modern rolling stock) to operate onwards up the WCML to Scotland, with possibly a 20 minute time saving.

Full interoperability with Europe, and an aspiration that principal UK cities have direct access to the European high speed network (which is standardising upon larger ‘Duplex’ rolling stock), dictate that upgraded routes must be engineered to city centre termini on the ‘Core Network’. (For CrossCountry and Transpennine flows, smaller UK-sized Javelin trains would be appropriate.)

However, this principle cannot be extended infinitely, and there will always be cases of onward running onto the existing network where budgetary constraints preclude construction of new lines (a major feature of French TGV operation). This is a particular issue for outlying Scottish destinations such as Aberdeen or Inverness.

None of these advantages apply with more radical technologies such as Maglev, unable to run beyond its dedicated route, and probably confined to out-of-town ‘parkway’ stations, with poor onward public transport connections.

Cost and Timescale

The construction of High Speed One has established a benchmark figure of £50M/km for high speed line construction. However, much of this cost is attributable to the considerable lengths of tunnel, viaduct, and extreme levels of environmental protection that were required. For a high speed route such as High Speed North, largely constructed along existing transportation corridors in generally less sensitive/adverse locations, a figure closer to the ‘engineering cost’ of £15M/km seems achievable. Allowing for complexities and general project costs, a figure of £30M/km seems a reasonable estimate, translating as around £30 billion for the core network and the Aberdeen extension.

Innovative means of finance, beyond the expertise of the author of this paper, are clearly essential; however, it is suggested that an incentive price is placed on tonne of CO_2 saved, and barrel of oil not needlessly squandered on aviation and other wasteful transport modes.

In terms of an engineering programme, 5 to 10 years seems a reasonable timescale for completion. However, timescale is largely dependent upon the importance that Westminster and Holyrood governments place upon the establishment of a UK high speed network, and upon a low-carbon transport future not dependent on dwindling global reserves of oil. Certain projections show oil supplies – and therefore price – going critical within the next 10 years, in which case urgent action becomes imperative.

In this context, it becomes not so much a question of ‘can we afford to have high speed rail?’ but ‘can we afford not to?’ Normal priorities, and timescales, will have to change.

HIGH SPEED NORTH
CORE NETWORK WITH
HEATHROW LINK