IARO report 12.09

High Speed Rail at Heathrow: an international perspective

IARO Report 12.09: High Speed Rail at Heathrow: an international perspective

Editor: Andrew Sharp

Published by

International Air Rail Organisation

6th Floor, 50 Eastbourne Terrace

London W2 6LX

Great Britain

Published with grateful thanks to those members who contributed to this report.

Telephone   +44 (0)20 8750 6632

Fax   +44 (0)20 8750 6615

website   www.iaro.com, www.airportrailwaysoftheworld.com

email   enquiries@iaro.com

£250 to non-members

*Our mission is to spread world class best practice and good practical ideas
among airport rail links world-wide.*

Contents

Introduction

Providing high speed rail services at Heathrow Airport has been an aspiration since the 1980s.

At that time the InterCity sector of British Railways put forward plans for a parkway station at Iver, on the Great Western Main Line adjacent to the M25 motorway: this would have been connected to the airport by shuttle buses. The idea was rejected by the government: it is understood that the reason given was that the buses would have needed to run through a projected motorway service area to reach the station, something not allowed at the time.

In more recent years, there has been much discussion about a high speed rail service at the airport. Various proposals have surfaced, led by Arup, Greengauge and BAA itself. Under these, it is likely that any station would be built as part of a new high speed line – HS2 – between London and the Midlands. The London terminal is likely to be in the St. Pancras area; and the line is likely to be integrated with HS1, the line to the Channel Tunnel. Also discussed is the concept of connecting South Wales and the West of England more efficiently to the airport by rail.

The 2M group, "An all-party alliance of local authorities concerned at the environmental impact of Heathrow expansion on their communities", has put forward an alternative proposal. This is for a high speed line from London to the Midlands and north following the line of the M1 motorway with a stop at an interchange station at Cricklewood. This station would itself have links to Heathrow in the south west and Stevenage and Cambridge to the north east.

An over-riding consideration of any proposal should of course be passenger need. A few people ride trains for pleasure: a smaller number fly commercial aircraft for pleasure. But the overwhelming majority travel because they are where they are and want the utility of being somewhere else – at a conference, at home, at a resort, at a meeting. They need to get between office, home or hotel and conference, resort or work site. These are usually remote from rail stations and even more remote from airports. The overall journey – in simplest terms, the feeder at each end and the line-haul in the middle – needs to be considered and made as easy, reliable and convenient as possible.

This report presents an international perspective on high speed rail stations at airports, something IARO is uniquely qualified to give.

Andrew Sharp

Director General

List of abbreviations and acronyms

ACI   Airports Council International

ACRP   Airport cooperative research program

BART   Bay Area Rapid Transit (San Francisco)

CAA   Civil Aviation Authority (UK)

CTA   Central Terminal Area (of Heathrow Airport)

EuroCAREX European Cargo Rail Express

GWML   Great Western Main Line

HS1   High Speed 1 – the rail link between London and the Channel
               Tunnel

HS2   High Speed 2 – the code name for a future second high speed
               rail link in Great Britain, probably connecting London and the
               West Midlands (and possibly beyond)

IARO   International Air Rail Organisation

ICE   InterCity Express - German high speed train

Km   kilometre

Km/h   kilometres/hour

MCT   Minimum connect time

O&D   Origin and destination

PRT   personal rapid transit

RER   Réseau express régional (express regional network – the
               medium distance suburban network for Paris)

S-Bahn   Stadtschnellbahn - City fast train (German speaking countries).
               Suburban railway.

TGV   Train à Grande Vitesse – French high speed train

UK   United Kingdom

2M group   An all-party alliance of local authorities concerned at the
               environmental impact of Heathrow expansion on their
               communities.

Note that UK conventions are used for dates (day/month/year) and numbers (in 9,999.99 the comma , separates thousands: the full stop . is a decimal point). A billion is a thousand million, following US conventions.

1. The options

There are essentially three options for an InterCity station to serve Heathrow Airport. These can conveniently be described as the Hub, the Wye and the Loop, and are referred to as such below.

The sketch map at the end of this chapter may help with orientation.

The Hub

The first option, which is essentially Arup's Heathrow Hub proposal, is to build a station on the existing Great Western Main Line (GWML). This would probably be the lowest cost option, because it would need relatively little track-work and no tunnelling.

However, the size of the necessary station should not be under-estimated – conceptually, at minimum, it would have two high speed tracks separated by a platform on the south side of the line, the existing two main lines separated by a platform, and the existing two relief lines on the north side again separated by a platform. The size of the Hub station is discussed further below (see page 33).

The GWML is 4 km north of the Central Terminal Area (CTA) at its nearest point just west of Airport Junction. However, it might be cheaper and easier to build a hub station to the west of the nearest point, closer to the M25 motorway, and connect it to the terminals by people mover.

An alternative location might be found to the east of Airport Junction in the Hayes – Southall - Ealing area.

> Immediately west of the existing Hayes station, between there and Airport Junction, there are disused industrial sites. This is where the Heathrow Express line (and, in future, the Crossrail service) diverge from the main line: there is unlikely to be space there for additional tracks and platforms.

> There is probably insufficient room at the existing Hayes Station site: it is quite constrained by its urban infrastructure.

> The Southall/West Ealing area is another possibility: there are freight sidings and tracks in this area, as well as Plasser's track equipment factory.

> A "Far east" option is at Old Oak Common, an extensive railway depot area to the west of Paddington. This has a number of advantages – in particular, space and railway connectivity.

> There is quite a lot of railway owned land in the area. That to the south of the line – the North Pole depot, formerly used by Eurostar – is currently disused. To the north of the line is an area used by a number of train operating companies for maintenance and stabling of trains.

Just west of Old Oak Common there is a little-used line towards Northolt and High Wycombe: the formation could be used for HS2. Further west is a freight line up to Acton Wells, with connections to the North London Line, the Dudding Hill Line and the West Coast Main Line. Old Oak Common is also physically quite close to the West Coast Main Line, so there could be a direct connection into Euston and (through the Primrose Hill – Camden Road link) HS1.

A down-side of the Old Oak Common site is the lack of adequate road access: improvements would not be easy.

The advantage of a site east of the present Airport Junction is that it could be served by Heathrow Express and Heathrow Connect (and, in future, Crossrail) trains to take passengers to and from all of the airport terminals. A location west of Airport Junction would need its own people-mover service to the terminals (for a discussion of this, see page 34, Hub station – people-mover issues).

A 4 kilometre automated people mover is possible, but would need to be of high quality and reliability.

The Hub option would cause the least delay to passengers not wanting to go to Heathrow: trains would follow their normal route, and presumably most would stop at the airport station. It is conventionally reckoned that adding a stop to a high speed service adds five minutes to the journey time (90 seconds station stop time, plus deceleration and acceleration)[1].

The need for an additional change of mode under this option is something air passengers will not like – it adds hassle (especially for passengers with luggage) and unpredictability. It will reduce patronage by air passengers - a major disadvantage of this option.

Parallels can be seen at Newark and Düsseldorf, for example: for others, see the section on "National and international parallels" starting on page 12.

The Wye

Another option, possibly the Greengauge idea, is to build a Y-shaped spur - a wye – into the airport. This would allow trains to run in and out of a station at the airport from the GWML in either direction. They could go into the airport on one leg of the wye, and either terminate at the airport station or the driver could change ends and drive the train out again on the other leg of the wye.

Conceptually, this would only need a relatively short tunnel – under the airport itself. Indeed, it might be possible to use the existing Heathrow Express route for the east-facing end of the new infrastructure – an option discussed further in section 5 below.

---

[1] Stuttgart - Hamburg ICE trains used to stop for four minutes at Frankfurt Airport station when they needed to load and unload containers of checked baggage.

It is not immediately obvious where the west-facing end would be, but a solution could emerge from the planning of terminal 6 – possibly a tunnel to the area near the existing M25/M4 intersection.

This short tunnel would make it a medium cost option.

The need for through trains to reverse would give rise to a longer journey time for passengers not travelling to or from Heathrow. The parallels may not be precise, but trains between Manchester and Wilmslow stopping only at Stockport take 16 minutes whereas those stopping only at the airport (and reversing there) take 35 minutes. Trains between Leuven and Brussels Nord stopping only at the airport (and reversing there) take 31 minutes: non-stop trains take 19 minutes.

If the Northolt line from Old Oak Common were used as the route to the Midlands and the north, a very substantial Wye would be needed. This would presumably use the existing route of the Heathrow Express into the airport, and a tunnel to somewhere in the Northolt area as the westerly end (or, alternatively, an upgraded West Ealing – Greenford line).

It is unlikely that such a routing would be used by through trains: it would be too slow. Dedicated trains between Heathrow and the rest of the country would be necessary. This is a major disadvantage. With trains serving London, Heathrow, the Midlands and beyond, the combined load would justify a reasonable frequency. Trains just connecting Heathrow, the Midlands and beyond would attract fewer passengers and would not justify such a frequent service – which would be a deterrent to use.

Examples can be seen at Manchester and Stansted Airports. However the Stansted wye is not normally used as such: services between London and Stansted use the southern arm, and those between Stansted and the Midlands use the northern one. See also "National and international parallels", starting on page 12.

The Loop

The third option is a loop off the GWML running to a station somewhere under the airport before rejoining the main line later.

This assumes that HS2 diverges from the GWML west of the airport. If it diverges east of the airport – for example if it uses the Northolt line from Old Oak Common – such a loop is probably infeasible.

This option probably has the highest cost because of the length of tunnel involved. The length of the tunnel depends partly on geography – what is physically possible in that area of west London – and partly on the design speed (tight curves at each end would give a shorter tunnel but a slower running speed). The current speed limit at Airport Junction, for example, is 75 miles/h (120 km/h).

At the east end, it is possible that the existing Heathrow Express line could be used – see the further discussion below.

If the existing Heathrow Express tunnels could not be used, new ones would be needed. This would be difficult. The area alongside the GWML is generally built up, with significant residential and industrial development. Sites in the Southall/West Ealing area appear to be possible, but given the proximity of the Grand Union Canal and the M4 motorway (about a kilometre south of the line) the loop would have to lose height quickly. A dive-under rather than a flyover is likely to be required at the grade-separated junction. It is likely that the minimum length of loop necessary would be 12 km.

The west-facing tunnel would have to be further west than that used for the wye option. However, doing this could make it possible for the loop to serve terminal 5 (which handles a quarter of Heathrow's traffic) as well as the central terminals.

Journey times for non-Heathrow passengers would probably be shorter than for the second (wye) option. This is because the station stop time is inevitably longer when trains have to reverse. Even if a second driver is provided, obviating the need for the driver to change ends, it takes time to re-set the points and crossings so that a train can operate over the same line in a different direction.

Parallels can be seen in Oslo and Stockholm, for example, although in Oslo in particular, the loop is quite a significant piece of railway infrastructure (44 km, including a substantial tunnel). See also "National and international parallels", starting on page 12.

The 2M concept

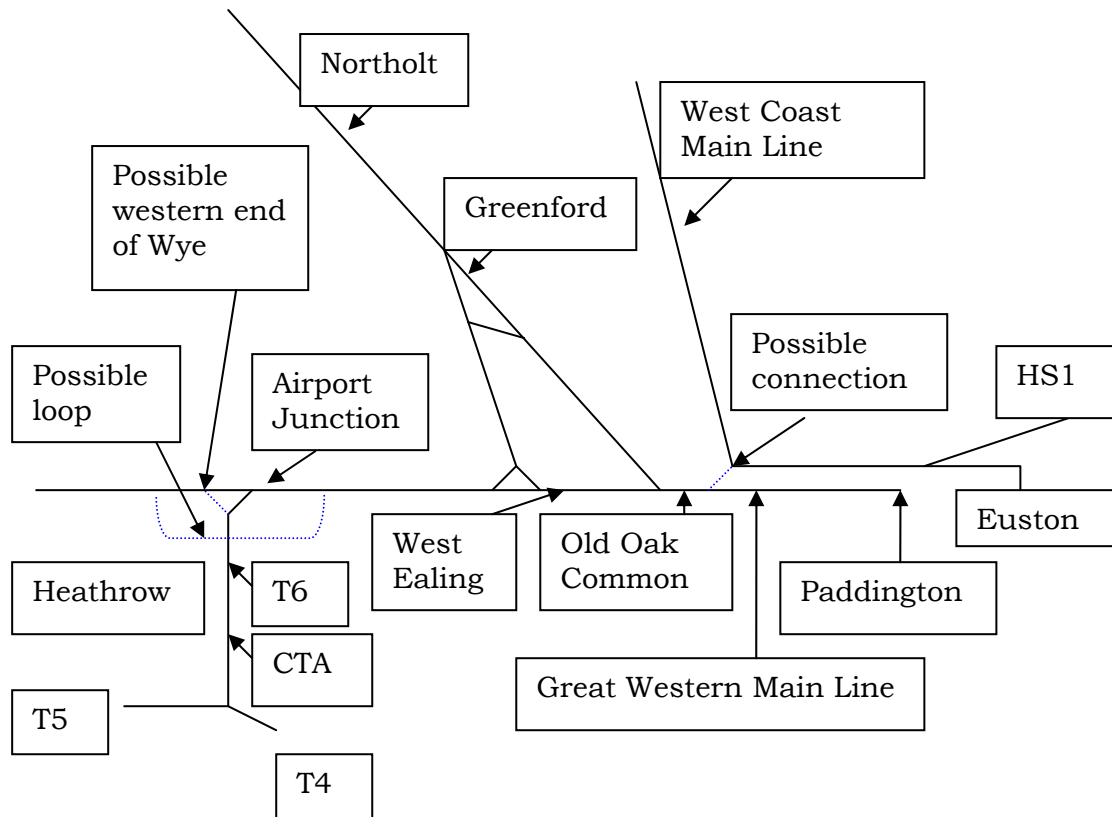The proposals of the 2M Group for Heathrow Airport are not entirely clear.

Their criticism of the other plans seem to be that they would add third-rail trains on the Airtrack line from Terminal 5 to overhead-line powered trains on the Heathrow Express line. In fact, BAA's consultation documents on Airtrack envisage Airtrack trains changing from 3rd rail to overhead power between Terminal 5 and Staines.

2M propose a hub at Heathrow, with a line from Heathrow Airport to the Cricklewood Hub (for HS2 to the north) as well as Airtrack to the south, Heathrow Express and Crossrail to the east and a "western arm" to Slough, Reading, South Wales and the South West.

It is not clear how this addresses their criticisms: however, it is assumed that as far as Heathrow is concerned these plans are compatible with the Wye option as described above.

Unlike the other proposals, these do not enhance connections to major London termini (something which, with the exception of Liverpool Street, Crossrail also fails to do).

Sketch plan of the area under consideration (not to scale).

CTA - Central Terminal Area

T4 – Terminal 4

T5 - Terminal 5

T6 – future Terminal 6

Existing lines are in black: possible lines are dotted and in blue.

2. National and international parallels

A few examples of international and national parallels have been given above. The section below, discussing world-wide examples of Hubs, Loops and Wyes on all types of airport railway, is believed to be complete.

After the name of each airport is its total passenger throughput (usually from airport or ACI data, usually for 2007 or 2008). The figures are in millions of passengers, and include all passengers boarding and alighting from flights – including those just changing planes at the airport.

Main line (hub) station option

Baltimore-Washington International (BWI) – 21.5 m passengers

This airport has a station on Amtrak's Northeast Corridor, connecting Washington DC and New York. Most Amtrak trains, including the Acela Express, as well as the MARC suburban trains between Baltimore and Washington DC, stop there. A frequent bus shuttle runs between the station and the airport's single terminal: it serves a number of points around the horseshoe shaped terminal. In the past there have been plans for some kind of automated people mover, but these have not yet come to fruition.

Because of Amtrak's perpetual funding crisis, the station is of low quality and in a relatively poor state of repair – although improvements take place from time to time. The bus shuttle works well.

Bus shuttle to BWI Airport at the Amtrak/MARC station

At the moment, MARC has no weekend service although there are plans to introduce one and to enhance the present weekday service frequency.

Nearly 600,000 people a year board and alight from Amtrak trains at the airport station.

Both services run approximately every hour in each direction.

Barcelona 32.8m passengers

There have long been plans for a station at the airport on the new high speed line between Madrid and Barcelona.

For some years, there has been a local train service to a stub-end terminal near the station.

Berlin Schönefeld 21.4m passengers

The station serving Schönefeld is a well signed 300 metre walk or dedicated shuttle bus ride from the airport's single terminal. The station opened for S-Bahn trains in 1962, and InterCity and regional trains in 1992. Among the regional trains are some between the Baltic coast and places south of the city which combine to provide a half-hourly non-stop express service between airport and the city centre: this started in May 1998.

The S-Bahn service is very frequent: regional express trains are half-hourly and InterCity trains relatively infrequent.

The airport is being totally re-constructed to become the new single airport for Berlin - Berlin-Brandenburg International Airport, with a much more comprehensive train service. See the Berlin-Brandenburg International entry in the Loop section below for details.

Birmingham 9.2m passengers

The airport is connected to Birmingham International station by an elevated cable-hauled automated people-mover which opened in 2003. The journey time is about 90 seconds: the service is very frequent.

The station, which also serves the National Exhibition Centre, has InterCity, regional cross-country and suburban trains to a wide range of destinations (three trains an hour each way between the West Midlands and London; four stopping trains an hour from Birmingham, some continuing to Coventry and beyond; an hourly Manchester – Bournemouth train and an hourly train from North or Central Wales). It sees about 2.5m passengers a year.

Track capacity is a major constraint. There are two tracks – one for each direction – between Birmingham and Rugby: the only places where fast trains can overtake stopping services are at the airport and at Coventry.

<u>Cardiff</u> 2.0m passengers

Rhoose station, on the Vale of Glamorgan Line between Cardiff and Bridgend, has a dedicated shuttle bus service taking 7 minutes for the 2.5km journey to the nearby airport. It opened in June 2005 and is used by about 150,000 passengers a year.

The hourly local trains in both directions call at the station simultaneously, so the same shuttle bus can very efficiently serve both directions of travel and passengers going both to and from the airport. They run between Cardiff and Bridgend.

<u>Düsseldorf</u> 17.8m passengers

The airport has had a local (S-Bahn) station (funded by the airport authority) since 1973. In May 2000, a second station opened on the Düsseldorf - Duisburg high speed and regional line adjacent to the airport. The free connection between the airport and the long-distance station is provided by a 2.5 km elevated people mover – the SkyTrain - or, sometimes, a bus shuttle. The people mover journey takes five minutes. Over 350 regional, local and InterCity trains call at the airport station each day.

Initially, in-town check-in was provided at the InterCity station: it received little use and closed in April 2004. The automated people mover has periodically suffered from technical problems.

Düsseldorf InterCity station: the former check-in area is in the background

East Midlands 5.6m passengers

A new 4-platform station opened in January 2009 to serve East Midlands airport, to which it is connected by bus shuttle, and the nearby M1 motorway. The station has both InterCity and regional trains (hourly services between Leicester and Lincoln, London and Nottingham, and London and Derby).

Luton 9.9m passengers

Luton Airport Parkway is a modern 4-platform station on the Midland Main Line with a high quality shuttle bus connection to the terminal, a distance of 1.8km on an intricate local road network. Before it was opened in November 1999, there was a much longer shuttle bus connection from the main station in Luton.

The parkway station is served by both InterCity and commuter trains. The former connect the airport to the East Midlands and run every hour. The latter run through central London to Gatwick and Brighton at least four times an hour, with additional half-hourly stopping trains between the airport and Sutton and Wimbledon via central London. It is used by over 2.5 million passengers each year.

Luton Airport Parkway station

The station site is constricted, which is reflected in some compromises in design. For example, connecting from the overbridge to the shuttle buses by escalator involves the use of four short escalators because of space constraints: one or two longer ones would have been more convenient, especially for people with bags. Planned improvements may eliminate this problem.

The station was intended as a parkway for the nearby M1 motorway, but limited parking space restricts this. The station is used by non-airport passengers: the split between airport and non-airport passengers is unknown.

Milwaukee 6.1m passengers

Milwaukee airport has a station on the Hiawatha line between Chicago and Milwaukee, with 7 trains a day in each direction. It opened in January 2005 and now has nearly 100,000 riders each year. There is a shuttle bus connection between station and the airport's single terminal. The station also functions as a park and ride station for the southern suburbs of Milwaukee.

Part of the motive behind building this station was to capture air traffic from Chicago's airports - O'Hare and Midway. There have been plans for in-town check-in and integrated ticketing at Chicago Union and Lake Cook stations, but because of problems in the US aviation industry, these have not yet come about.

Milwaukee airport station, shortly after opening

Montreal Trudeau (formerly Dorval) 12.4m passengers

Two stations – an InterCity station on the Montreal – Ottawa – Toronto line and a local station on the parallel commuter line – serve the airport. They are connected to it by shuttle bus.

Since 1999, it has been possible for train travellers to check bags from Ottawa to Montreal airport: they have to collect them at the airport and check them in for their flight.

There are about 6 InterCity and 13 commuter trains a day.

Plans for a station at the airport itself are well advanced. While both a Wye and a Loop have been discussed in the past, current plans are for a stub-end line running into a terminal station at the airport. A station site has been identified in the international area of the terminal under the new airport hotel.

Newark 36.4m passengers

In 2001, a 4-platform airport station was opened on Amtrak's Northeast Corridor. It is served by Amtrak regional trains and New Jersey Transit commuter trains. It is connected to the three terminals and the parking and rental car areas by a 1.6km extension of the airport monorail (Airtrain Newark) which opened in 1996: there is no public road access. Journey time is 5-8 minutes, depending on the terminal used at the airport.

Newark Liberty International Airport Station: the people mover is on the left

All passengers using the station have to pay a $5 surcharge on their fare: this allows the owners, the Port Authority of New York and New Jersey, to recoup the construction costs.

When the station opened started there was a Continental Airlines check-in desk between platforms and monorail: this received little use and was closed.

A code-share between Continental Airlines and Amtrak has been in operation since February 2002. Continental Airlines' passengers travelling to and from Stamford and New Haven (Connecticut), Wilmington (Delaware) and Philadelphia can change between train and plane at the airport, travelling on an integrated ticket[2].

The station itself is impressive, although it suffers from the lack of a dedicated train service. There are times when there is a 40 minute gap between trains to downtown New York; and tickets are not inter-available between New Jersey Transit and Amtrak trains.

It is used by 1.38 million passengers a year (mainly on New Jersey Transit services which run four times an hour: there are just over 100,000 passengers a year using the approximately hourly Amtrak services).

New York JFK 47.8m passengers

Two stations – Howard Beach, on the New York subway, and Jamaica, on both the subway and the Long Island RailRoad – are connected to the airport by automated people mover (Airtrain JFK). The people mover also serves all nine terminals at the airport. Users of the two interchange stations have to pay a $5 fare, although the inter-terminal shuttle is free.

Ticketing is complex but seems to be generally understood and accepted. Interchange is relatively easy, although the walk between the subway and the Airtrain at Jamaica is quite long and involves major changes in level.

The Howard Beach branch is 5.5km long, the Jamaica branch 4.8km and the airport circulator 3.2km.

This is the kind of distance involved at Heathrow. The 4.8km to Jamaica take 8 - 12 minutes (depending on the start point within the airport): according to the Port Authority of New York and New Jersey, it takes 18 minutes for the 5.5km from Howard Beach to the BA Terminal.

Howard Beach has a frequent 24-hour service to Manhattan on the A Line of the New York Subway. Jamaica has a similar level of service on two subway lines and on the Long Island RailRoad.

---

[2] More information on this and other air-rail code-shares is available in IARO's report 11.08: "Case studies in cooperation between air and high speed rail".

Airtrain JFK at the airport.

Howard Beach station – subway platforms and Airtrain connector bridge

Oakland 14.6m passengers

Oakland International Airport is connected to the BART suburban rail network and Amtrak Capital Corridor regional trains by the AirBART shuttle bus service which runs between Coliseum station and the airport's two terminals every 10 minutes. The fare is $3 for the 3.25km ride.

BART runs about every seven minutes to downtown San Francisco. There are six Amtrak trains a day, running between Sacramento and San Jose calling at Coliseum station.
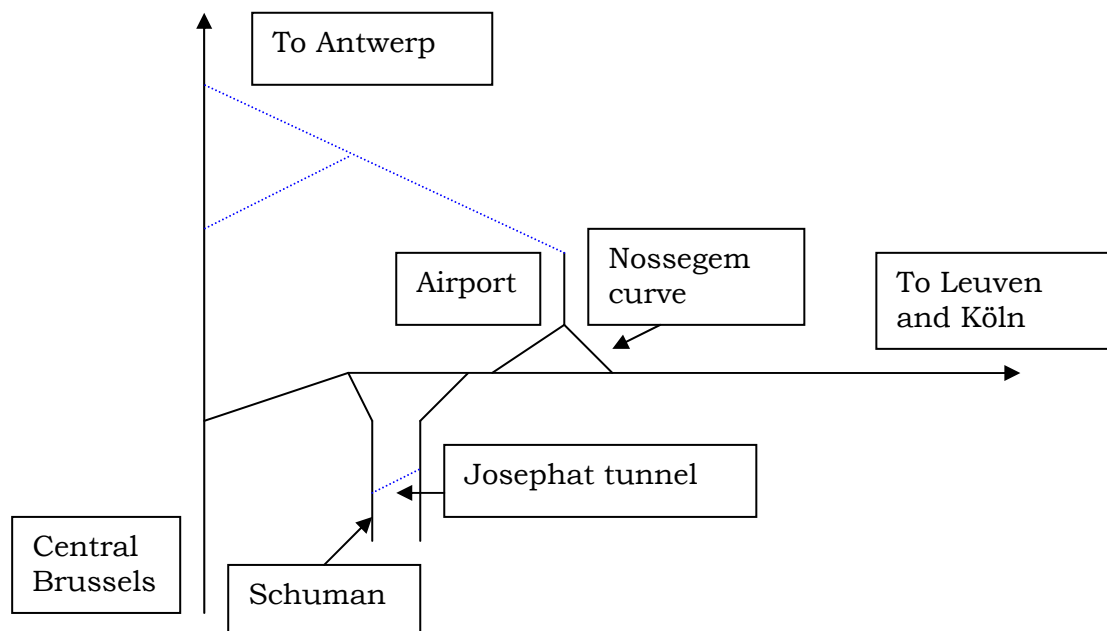
There have been plans to enhance the quality of this by constructing a rail or automated people mover link, but until recently there has been no funded scheme. The project appears to have been revived under the recent stimulus funding package.

Wye option

Brussels 17.8m passengers

The railway at Brussels International Airport has a long history. Initially there was just a spur from the western (Brussels) direction into the airport, extended by 1.6km into a new larger airport station directly under the airport's single terminal in 1998. This has good connections into the terminal by lifts.

At the end of 2005 another (eastern) branch, the Nossegem Curve, was built, creating a wye. For information on future plans – a double wye and double loop – see under Loop Option below.

Sketch of Brussels airport connections. Not to scale. New infrastructure is dotted and in blue.

The airport is served by four regional trains an hour from Brussels and the west of Belgium, and half-hourly trains from the east (Leuven) on the Nossegem Curve. A new tunnel is being built which will create a direct route for trains between the European Quarter (Schuman station) and the airport, using the western leg of the wye.

Manchester 22.4m passengers

When the rail link into Manchester airport was provided in 1993, only the northern part of the wye (towards Manchester) was built. Subsequently (1996) the southern curve – towards Crewe – was constructed, partly funded by the airport authority. A third platform was completed at the end of 2008: this significantly increased the capacity of the station.

The station is served by local and regional trains, the latter to a wide geographical area (including Leeds, York, Newcastle, Edinburgh and Glasgow). As well as an hourly service between Manchester and the Airport, it has hourly trains to and from Newcastle, Glasgow/Edinburgh, Middlesbrough, Blackpool, Liverpool, Cleethorpes, Southport (all serving central Manchester) and Crewe. It is used by over 2 million passengers a year.

The local train operators are highly regarded, although the complex rail geography of central Manchester sometimes gives rise to delay and reliability issues.

The level of service at the station itself is high – it is, for example, normal to be offered a self-help trolley when alighting from a train at the airport.

Vertical circulation is good, with ramps, escalators and lifts. There are overhead connectors, incorporating moving walkways, from the station to Terminals 1/3 (250 metres) and 2 (450 metres).

San Francisco 35.8m passengers

San Francisco airport is served by BART trains from the city: these use the northern leg of the wye and terminate at the airport station. Initially trains also shuttled between the airport and Millbrae, on the regional Caltrain line, using the southern leg, but this service no longer operates.

The BART service to the airport, which appears to be well used, started in June 2003: it now runs four times an hour.

The line serving the airport was deliberately built with the airport at the apex of a triangle, on the somewhat dubious argument that if terrorists armed with explosives took over an airport-bound train intending to detonate their cargo at the airport, the train could be diverted away from it on the third side of the triangle.

The airport layout is such that the connection to the international terminal is easy. To reach other three terminals either takes a long walk or a change of level and a ride on the inter-terminal people-mover.

<u>Stansted</u> 22.3m passengers

The line from London, used by the quarter-hourly Stansted Express and hourly local trains from London and Stratford, forms the southern half of the wye. The line from the Cambridge direction, served by hourly regional trains from Birmingham and Peterborough, forms the northern half.

Constraints include the track layout on the approaches (with much single track restricting frequencies) and the station layout (with two long platforms – 291 and 274 metres long - and one short platform 91 metres long).

Under Stansted's Generation 2 project, BAA has applied for Transport & Works Act consent to add a fourth platform, and a second bore to the single track tunnel under the airport.

Vertical circulation to the main terminal is good, although it can involve a long walk for passengers who are at the wrong end of the train. Passengers using the midfield terminal have to reach it by airside automated people mover.

The train service to the airport started in March 1991 and is now used by 5.5 million passengers each year.

Loop option

<u>Amsterdam</u> 47.8m passengers

Schiphol airport station is on the diverted Amsterdam – Den Haag route. Until 1979, the main line used to go via Haarlem: the present route goes under the airport.

It has a good mix of local, regional and international services with frequent services to Rotterdam, Amsterdam Central, Brussels, Paris, Utrecht and Den Haag. These are to be supplemented at some point by trains on the new international high speed line to the south, HSL-Zuid, which has its own infrastructure south of the airport but will use common infrastructure between the airport and Amsterdam.

The station is underground, with 6 platforms: the line feeding it has had 4 tracks since widening in 1999 and is highly congested. The entrance to the station is inside the airport's single terminal (which can also get very congested).

There are plans for a bag-drop by the platform exits.

Thalys and KLM code-share between Schiphol and Antwerp: KLM no longer fly the route but its passengers can use the high speed international trains on a combined air-rail ticket.

Amsterdam Airport Schiphol station exterior

Berlin Brandenburg International 21.4m passengers

The former Schönefeld airport is being extensively rebuilt as the new single airport for Berlin - Berlin-Brandenburg International Airport, to open on 1 November 2011.

The station under the terminal has already been built, with 6 platforms. It will be served by local, regional, international and Airport Express trains.

Brussels 18.4m passengers

Brussels Airport station as it is and was has been described in the Wye section above (see sketch plan, page 21). There is an old north to west connection between airport and Brussels and a new north to east connection – the Nossegem Curve – to Leuven.

A second wye is being built which will create two loops connecting at the airport station. The south to north leg of this wye will connect the airport to lines in the Antwerp direction: the south to west leg will connect the airport to Brussels. So it will be possible to run from Brussels to Germany via the airport and Leuven, and from Brussels to the Netherlands via the airport – or indeed from the Netherlands to Köln via the airport.

Planned opening date is June 2012.

Frankfurt 54.2m passengers

Frankfurt airport has two stations – the regional station, underneath terminal 1, and the newer high speed station, connected to it by an overhead walkway.

The former was built first (in 1971), and for a while only had a local S-Bahn service. This was subsequently supplemented by regional trains (1973) and international trains (1985).

The high speed station – known as the AIRail station – was built to serve the high speed line between Frankfurt and Köln, and is used by long distance ICE trains between the north and south of the country. It opened in 1999. The route between train and plane is complex, involving a long walk assisted by moving walkways or (for terminal 2) a bus shuttle.

Integrated ticketing and check-in is available for passengers changing between train and plane at Frankfurt airport for trains to and from Stuttgart, Köln and Bonn. Originally this included through checking of baggage, but this ended in November 2007. However, the check-in desks of Terminal T, adjacent to the exit from the high speed station, function as a bag drop and as a check-in point for air passengers arriving by train.

Købehavn (Copenhagen) Kastrup 21.4m passengers

The Øresund Fixed Crossing between Denmark and Sweden was built with a station at Kastrup airport. Terminal 3 was modified so that connections between train and plane were very easy – 60 metres from platform to check-in. Connections to the other two terminals are relatively easy.

The station, which has two 320 metre platforms, was opened in September 1998: through trains to Sweden started running in 2000. It is used by regional trains to Købehavn (six an hour) and Helsingør (three an hour) as well as to the west of Denmark in one direction, and to Malmø and southern Sweden three times an hour in the other. There is a regular alternate hours high speed service to Gøteborg and Stockholm using tilting X-2000 trains.

The sub-surface station is awkwardly integrated with the high-level metro: access to the terminals is vertically between the two.

Köln/Bonn 10.5m passengers

A station to serve this airport was built on a 15 km loop from the Frankfurt – Köln high speed line. About half of the line, which opened in June 2004, is in tunnel.

It is served by ICE high speed trains (which run approximately every hour); and half-hourly local S-Bahn trains provide a frequent service between the airport and Köln.

The airport has two terminals.

Leipzig-Halle 2.5m passengers

As part of the reconstruction of eastern Germany, the airport at Leipzig-Halle was extensively modernised. There is a new railway between the two runways, with a station incorporated into the new terminal building. As passengers leave the station, they go straight into the check-in area on the connector bridge. This leads to the rest of the terminal area.

There is a half-hourly shuttle between the two cities, serving the airport and the trade fair (Messe) site, and an extensive but less frequent regional train network.

The city shuttle started in December 2002, and regional services started six months later.

Leipzig-Halle airport station, showing check-in area above the platforms.

Lyon St-Exupéry 7.9m passengers

This airport has a station on the high speed line by-passing the city of Lyon: it opened in July 1994. Sadly it is more impressive for its architecture than its train service, which is sparse and idiosyncratic.

It is a short walk from the airport's three terminals.

One view is that the railway does not see value in stopping its Paris – South of France trains there: the stop would consume valuable train paths and people travelling between Paris and Lyon would use the main stations in Central Lyon rather than the one out at the airport.

Extensions to the rail network in the area may give the station a more appropriate level of service.

Lyon St-Exupéry station

Oslo 19.0m passengers

When Oslo's new airport was built at Gardermoen in 1998, it included a new sub-surface station with an Airport Express to the city. The station has three 350-metre platforms.

A requirement of the new airport was that the time taken to access it should be the same as the access time to the old down-town airport at Fornebu – 19 minutes. This necessitated a new high speed 48 kilometre loop line through the northern suburbs of Oslo, eliminating many of the curves in the old line, which it rejoins at Eidsvoll, a few kilometres north of the airport. It includes a 19 kilometre tunnel: the service started when the new airport opened in 1998, but the tunnel was then incomplete so the trains used the old line between Lillestrom and the city until August 1999. This loop is also used by regional and InterCity trains between Oslo and the north.

The Airport Express runs six times an hour: local trains are approximately hourly.

The train to plane connection is very easy – up one escalator to arrivals level then up another to departures.

<u>Stockholm Arlanda</u> 18.0m passengers

In the mid 1990s, Arlanda airport was given consent to build a third runway if it also facilitated an Airport Express between city and airport. This necessitated construction of 20 km of new railway and 22 km of new double track (quadrupling the line to the north of Stockholm). This line, which opened in November 1999, has three stations in deep tunnel under the airport – two for the Arlanda Express and one for regional and local trains. The latter can continue north of the airport and rejoin the original main line to Uppsala and the north.

The two Airport Express platforms each have exits at each end, serving the four terminals and the Sky City commercial area very effectively.

The rail infrastructure is operated under a concession: Arlanda Express gets revenue from the State Railways for each train they and any other train company operate into the airport.

There are 4-6 Arlanda Express trains each hour. There is a half-hourly commuter train service running between Uppsala and a station to the north of the Stockholm conurbation, and 70 long-distance trains each day serving the north, south and west of the country.

Arlanda Express at the station for Terminals 2 and 3

<u>Sydney</u> 32.3m passengers

In May 2000, a new 10 km commuter line was built, mainly in tunnel, in the south western suburbs of Sydney. The main objective was to by-pass a congested area where a number of commuter lines met, but it was also seen as advantageous to build stations under the airport (which happened to be on the optimal route). One station serves the domestic terminal: a second is under the international terminal. The two minute inter-terminal transfer costs A$5.

The airport line is served every ten minutes by commuter trains from the western suburbs. These are often double-deck units, very full in the peaks with little room for air passengers or their baggage. These trains necessitated a 10.5 metre diameter single bore tunnel.

In Sydney, trains go to the Circular Quay area south of the Harbour Bridge. Most Qantas frequent fliers live north of the bridge, so patronage from them is low.

The funding of the project was complex: the project itself was controversial because of local opposition to the airport itself. Trains, infrastructure and stations each have different owners. A premium fare is charged at the two airport stations: this is unpopular[3].

Paris Charles de Gaulle – the anomaly

Paris Roissy Charles de Gaulle Airport is a bit of an anomaly. Terminal 2 straddles the Grande Ceinture line which circles Paris: the airport is served by high speed trains between Brussels, Lille and major domestic destinations in France as well as by regular (8 trains an hour) RER trains to central Paris and on to Orly airport.

It is certainly not a Wye. It is on a loop, although unlike other examples cited above, the loop was there long before the airport and was not built with the airport in mind. It could just about be described as a Hub, because the station is connected to terminals 1 and 3 by automated people mover.

California High Speed Rail project

The California High Speed Rail project has been looked at to see if there are any useful lessons here, but it is at such an embryonic stage that none can be drawn. Some of the stations specifically serve airports and others could when their exact location has been decided. Those which explicitly serve airports are as follows.

---

[3] Indeed, the airport authority's web-site says, "Sydney Airport is not responsible for the fares set by Airport Link."

Millbrae/SFO, for San Francisco airport.

The station is between one and two kilometres from the airport, to which it is connected by BART subway train.

Palmdale (LA/Palmdale airport).

The obvious routing, following the existing Metrolink line, would go within a kilometre of the airport.

Burbank.

The existing Metrolink and Amtrak line goes about 2 km west of the airport, with stations both at the airport and the city (a shuttle bus connects both stations to the airport itself).

Ontario (LA/Ontario airport).

The obvious routing, following the existing Metrolink line, would go within about a kilometre of the airport.

San Jose

The present Caltrain station is close to San Jose airport and connected to it by a frequent shuttle bus.

Separately, a multi-agency committee is looking at the future of San Diego airport. Its key proposal includes a hub station on the regional and light rail networks, with provision for a high speed rail station.

3. The importance of non-airport traffic

Non-airport traffic on HS2 will be significantly more important than Heathrow traffic, which is why stress was laid in the options section on the impact of each option on non-airport passengers.

One estimate, given at the "High speed rail to Heathrow" conference in 2008, was that only 10% of people on a London – Manchester train would be using the airport station. These people would either be accessing the airport itself or using the airport station to reach nearby parts of the south-east.

All of the options would allow some trains to run past the airport without stopping, and all will involve different journey times for non-airport traffic.

With the hub option, trains could pass through the station without stopping. With the Wye option, again trains could bypass the airport by not using the wye into and out of the airport. Similarly with the loop, trains could continue to use the existing line without passing through the airport.

The Hub station option would delay through trains stopping there by around five minutes.

Heathrow Express trains take 4 minutes between Airport Junction and CTA, so the additional journey time necessary for the Wye option is around 15 minutes (twice 4 minutes plus a station stop time of 5-7 minutes, depending on train length). This assumes that HS2 will diverge from the GWML west of the airport. If the Northolt line from Old Oak Common is used, Heathrow will need a dedicated service: it would be highly unattractive commercially to run trains into Heathrow and out again on this route between London and the Midlands.

The Loop would need to be at least 12 km long (between the Southall area and the M25/M4 junction area). This is about 6 km more than the direct route: at 120 km/h, this would increase the journey time by around eight minutes (three minutes plus five minutes station stop time).

The 2M proposal, for a dedicated branch from Heathrow to the Cricklewood hub, will give the airport a lower level of service than a station on the line of route. This is also true of the Northolt line option (see above). Other options allow for a combined load of London plus Heathrow traffic on the same train: the service frequency would be driven by the requirements of the combined load. The 2M proposal would need dedicated Heathrow trains with a frequency driven by the much lower loads available at Heathrow alone. Under this option, Heathrow passengers may also have to change trains at Cricklewood.

Both of these factors – lower frequency and the possible need for interchange - would reduce use: this lower use would have to be balanced against the faster journey time for the larger numbers of non-airport passengers.

The difference in journey time between the 2M proposal and the GWML options has been estimated by assessing the direct distance between London and Coventry (around 135 km) and the distance between London, Heathrow and Coventry (around 145 km). The extra 10 km itself would add some three minutes to the travel time (at 180 km/h).

While HS2 is unlikely to be able to follow the shortest possible route, what matters is the difference between the lengths of the two routes rather than their absolute magnitude. The difference is assumed to be constant.

4. Railway technology, local geography and traffic

Traction issues

The first option, a hub station on the GWML, is the only one which would not require all trains to have electric traction. It would not be impossible to run self-propelled trains in tunnel under Heathrow, but catering for diesel trains there would be significantly more difficult because of the need to disperse fumes and the increased fire risk.

The ability of both diesel and electric trains to use the station would have one clear benefit. The HS2 options all serve the Midlands and (possibly) Scotland: the main areas badly served by direct train or plane from Heathrow are South Wales and the West of England. While electrification of the GWML is a high priority, it is unlikely that electrification would allow such comprehensive services as these areas currently enjoy. Hence places like Plymouth, Swansea, Carmarthen and Penzance could have direct access to Heathrow under the Hub option.

The second option, the wye, would need trains with a driving cab at each end – something common on modern rolling stock.

Terminal location issues

The issue of where to put an airport station (and, for cost and journey time reasons, there is likely to be one or possibly two) is not easy. Inevitably, it is likely to be a compromise.

The nearest main line is 4 km north of the central terminal area, and while terminals 1, 2 and 3 are conveniently grouped in this central area, terminal 4 is well to the south, terminal 5 well to the west and the planned terminal 6 will be well to the north of this.

This is a strong argument for the GWML hub option, especially when considering the fact that most passengers on the trains will not be using the airport. With an efficient transportation system connecting it to the three (future four) terminal areas, it could be more efficient than a central station and the need to use Heathrow Express, Heathrow Connect or the Piccadilly Line to get between there and terminals 4, 5 and 6.

The need for easy connections between the HS2 service and the Heathrow service impacts on the design of the Hub station.

Passengers will want to connect to and from the new high speed line in four ways - between the HS2 service in both directions and the Heathrow trains in both directions.[4]

---

[4] From a westbound HS2 train to Heathrow, from an eastbound HS2 train to Heathrow, from Heathrow to a westbound HS2 train and from Heathrow to an eastbound HS2 train.

They will also want to connect between Heathrow trains and conventional trains to and from South Wales and the West of England, but probably not between Heathrow trains and conventional trains to and from London.

These will be air passengers, probably with luggage, and will want the connection to be as easy as possible. Changes of level should ideally be avoided: where they are unavoidable, capacious assistance (large lifts, moving walkways and multiple escalators) is needed.

With the Wye or Loop options, the station could be at CTA, Terminal 5 or the future Terminal 6. Each has advantages and disadvantages in terms of factors such as costs, risks, and access to the terminals.

For the wye option, the best station location is likely to be at CTA, where passengers for other terminals would change onto Heathrow Express or Heathrow Connect/Crossrail. However, with this option, it would be also be sensible to provide a new station to serve terminal 6, then a central station serving terminals 1, 2 and 3. It would also be possible to provide a third station for terminal 4 or terminal 5 where trains would reverse[5]. Passengers for the un-served terminal would need to change at the central station. This three-station solution would increase through journey times significantly, and is unlikely to be justified except for some kind of local service (especially if Airtrack continues beyond Terminal 5 to CTA and Terminal 6).

The loop option brings the possibility of two stations, serving both the CTA and Terminal 5 – and it needs to be remembered that Terminal 5 handles a quarter of Heathrow's passengers. The loop option would be the most convenient for airport passengers.

Hub station issues

The hub station would need to be quite large.

It would have a minimum of six tracks through it – the existing two main lines and two relief lines, plus two high speed lines. If all of these had platforms, space for 6 platforms would need to be added to the space needed for the tracks themselves.

The minimum space (4-platform) option would probably include platforms only on the existing main and relief lines. The main line platforms would be used by HS2 trains stopping at the airport – although this would need high speed crossovers at each end of the airport station for HS2 trains to cross to and from the main lines.

The 6-platform layouts could be either

1. Side platform 1 – 2 tracks – centre platforms 2 and 3 – 2 tracks – centre platforms 4 and 5 – 2 tracks – side platform 6 or

---

[5] A station at Terminal 5 would give the option of running through to the south and south-west of London on Airtrack.

2. Track – centre platforms 1 and 2 – 2 tracks – centre platforms 3 and 4 – 2 tracks – centre platforms 5 and 6 – track

The 4 platform layout could be

3. 3 tracks – centre platforms 1 and 2 – 2 tracks – side platform 4.

The width of a single platform is assumed to be 3 metres and for a centre platform, 6 metres. Standard track gauge is 1.435m: there is an allowance of 2 metres between adjacent tracks.

Options 1 and 2 would take up a width of 30 – 35 metres, and option 3 around 25 metres – plus, potentially, space for the connector to the terminals.

Crossrail platforms are going to be 250 metres long, for 12-car trains: the platforms at Terminal 5 are 212 metres (for 9 x 23 metre vehicles or 10 x 20 metre vehicles). The longest high speed train in the UK has two 18-metre power cars and nine 23-metre passenger vehicles – a total of 243 metres. Trains can be longer than this, but of course longer trains will have more seats and are therefore likely to be operated less frequently.

Arup's proposals published in May 2008 identified a site 3 km north of Terminal 5 as having maximum connectivity and minimal impact on the airport. The cost was forecast to be less than £10bn.

Hub station – people-mover issues

If a people-mover between hub station and airport was needed, it would have to be highly reliable, technologically advanced and comprehensive, because of the complex terminal geography at Heathrow and because of the need to cover the distance between the new GWML Hub station and the terminals in reasonable comfort.

The 4 kilometres is equivalent to the ride on Airtrain JFK in New York, which takes 8-12 minutes. However reliable, there will have to be a back-up: having passengers stranded at a hub station unable to access the terminals would be a public relations disaster.

A model may be the automated people mover system currently on trial in Heathrow between one of the business car parks and Terminal 5. This is the ULTra PRT, a system of automated driverless pods carrying up to 6 people non-stop between two points. It is described as, "Public transport waiting for you rather than you waiting for public transport". The major advantage over conventional automated people movers is that it goes directly to where its passengers want to go – so conceptually, people would alight from a main line train at the Hub station and each passenger or group of passengers would board their own pod adjacent to their own carriage and go straight to their own destination within the Heathrow complex.

Loop station issues

The station could be under CTA, T5 or the future T6.

It is possible that, if T6 is built, Airtrack will be extended from its planned terminus at T5 through CTA to T6. If this is done, a new station is likely to be built on the Heathrow Express line between CTA and Airport Junction by excavating down to the existing tunnel and building two platforms and two new tracks on the existing north-south alignment. It would be possible to construct the loop station at the same point on an east-west alignment.

Construction and track layout issues

Both tunnel options would need more complex trackwork (especially at the two junctions, which would almost certainly have to be grade-separated) than the GWML hub option.

The impact of construction work on the existing railway should not be under-estimated.

On the main line, this would be serious: the need for points and crossings to be installed and re-signalling to be done would cause considerable dislocation of services. Options needing new grade-separated junctions would obviously involve much earth-moving: those involving a dive-under would also need careful planning to impact as little as possible on existing services.

There are currently proposals for major reconstruction and upgrading work at Reading station at some point before 2014: this will cause major disruption. Work associated with the Crossrail project (forecast to open in 2017) includes electrification and a new flyover at Hayes. The impact on the travelling public and the significant amount of freight traffic on the line of these three schemes together needs to be taken into account.

It could be argued that this is in fact an opportunity – a number of projects could be undertaken simultaneously during several extended closures, rather than just working on one. In an ideal world this would no doubt happen, but unfortunately it is unrealistic to expect it: the coincidence of project planning, funding and authorisation is unlikely to happen.

The Airtrack project (completion 2019?) could involve just a new line into Terminal 5 from a disused freight line from Staines, but a more ambitious add-on is to terminate services at Terminal 6. This would involve excavating the Heathrow Express bored tunnel in that area and building two new tracks alongside. Terminal 6 and runway 3 are unlikely to be started before 2015, and could take up to a decade to complete.

If new infrastructure was to be added to the existing Heathrow Express tunnels – perhaps a west-facing exit onto the main line to facilitate the Wye option, or a new underground loop to serve new platforms – again, there would be considerable disruption to existing services. Heathrow is not a 24-hour airport, but certainly both weekdays and weekend are busy for 17-20 hours a day. Building new tunnels and connecting them to an existing working railway at both ends is complex.

Passenger flows

Heathrow is a strong traffic generator for the rail network, with the potential for more. Few of its 44 million annual terminating passengers have Heathrow as a destination.

There is limited publicly available data on the flows likely to divert to rail.

As a guide, 60% of the 1.5m passengers using Paris Charles de Gaulle Airport TGV station in 1999 were air passengers. By 2003, these figures had grown to 65% and 2.4m passengers. Heathrow, like Charles de Gaulle, is highly accessible from the national motorway network, making it in principle an attractive place for a park-and-ride type of operation.

The advantage of a station at Heathrow for interlining traffic can be illustrated by the case of the Birmingham to Hong Kong route.

> Travelling by air between these two cities, one is offered five flights a week – changing planes either at Paris Charles de Gaulle or Amsterdam Schiphol.

> Travelling via Heathrow instead, one has the choice of five flights a <u>day</u>, on 3 different carriers, two of them UK-owned. Making this option easier for people to use has obvious advantages for the travelling public and UK plc.

The need for a high speed rail service does depend on the UK origins and destinations of its passengers – are they mainly south east England, South Wales and the West of England, or the Midlands?

Current information is available from the CAA's continuing surveys.

Other immediately accessible information is given in the consultation on the future development of air traffic ("The future development of air traffic in the United Kingdom: South East", second edition, February 2003).

Table 7A on page 50 shows total air travel demand by district, and the percentage of this demand at Heathrow.

By far the largest generator of traffic was central London – a demand met by current and planned train services.

Apart from London, all of the 44 Districts where more than 40% of the 2000 air traffic demand used Heathrow were to the north-west, west and south-west of the airport – essentially a triangle comprising the counties of Oxfordshire, Wiltshire, Dorset and Hampshire, and parts of Buckinghamshire, Surrey and Berkshire.

This is confirmed by the following table, extracted from the airport's Surface Access Strategy.

Surface O&D for all non-transfer passengers departing Heathrow 2006

From "A surface access strategy for Heathrow 2008-2012" page 37, table 2

	Million passengers
Inner London	14.874
Rest of UK	7.986
Outer London	7.570
Berkshire	2.721
Surrey	2.371
Hampshire	1.743
Oxfordshire	1.263
Buckinghamshire	1.070
Hertfordshire	1.045
W. Sussex	1.002
Kent	0.812
Essex	0.811
E. Sussex	0.562
Bedfordshire	0.361
Isle of Wight	0.077
Total	44.268

As a comparison, Heathrow Express carries something over 5 million passengers a year.

So the airport does not attract large numbers of people making long surface access journeys – perhaps 10 million a year from outside the triangle described above.

What about interlining passengers – people travelling between a UK regional airport and an international destination and changing planes at Heathrow?

A recent CAA report, "Connecting passengers at UK airports", gives some information about numbers of interlining passengers at Heathrow[6]. It counts interlining passengers twice, once as an arriving passenger and once as a departing passenger. In 2007, by this definition 23.5m passengers changed planes at the airport, although the bulk of these – 76.1%, 17.9m – involved passengers changing between two international flights. The remainder (5.6m connections, or 2.7m individual passengers) were changing between domestic and international flights, with none transferring between two domestic flights.

So the total number of potential passengers on a new connection is a proportion of the 8 million "Rest of UK" in the table above, plus a proportion of the 2.7m interlining between domestic and international flights.

---

[6] Data are in Chapter 3 of the report

Clearly, it would just be a proportion and not the total. It is reasonable to expect passengers to travel by train between places like Newcastle, Leeds, and Manchester and Heathrow to catch a flight: places like Edinburgh and Glasgow are much less likely because of the train journey time. Places like Inverness and Aberdeen are highly unlikely to generate interlining rail traffic to Heathrow.

The CAA report lists the top few city pairs involved in interlining: UK trip ends in the top ten routes include Manchester (135,000 individuals), Edinburgh (85,000), Glasgow (28,000) and Aberdeen (12,000).

How would interlining between train and plane work?

It is known that in 2007, 980,000 passengers (30% of Manchester airport's total passengers) flew between Heathrow and Manchester. Of these, some 680,000 were interlining (changing planes) and are therefore only likely to divert to rail if trains go direct to the airport and the connections there are good, with a minimum connection time (MCT) between train and plane equivalent to that between plane and plane.

Flights from Manchester arrive at Heathrow's Terminals 1 or 5. From Terminal 5, the minimum connection time to other terminals is generally 90 minutes (110 minutes, to Terminal 4). From terminal 1, the minimum connection time is generally 75 minutes. Could a train to plane connection match that?

> Assume that passengers have to be at security 60 minutes before the flight departure time.
>
> It can take ten minutes to get from Heathrow Express to the worst-placed terminal. Worst case is that the people-mover station from HS2 is in the same place. Assume that a people mover from the hub station takes 10 minutes (two minutes less than in the longer JFK example): if it runs every 5 minutes, there is a maximum wait time of 5 minutes. It is probably also reasonable to assume a five minute access time – from leaving train to boarding people mover.
>
> That gives a train-to-security time of 30 minutes, and a minimum connection time of 90 minutes.
>
> This would work for people without hold baggage, and with a boarding pass. People with hold baggage would have to allow more time: those without a boarding pass would also need to allow time to get one (quick, these days, with self-service kiosks – which, of course, could be provided at major stations).
>
> At Frankfurt, minimum connection time between plane and plane or between train and plane is 45 minutes – despite the long walk between train and terminal.

The minimum connection time is important: what can also be important is the timing of the connection.

Someone catching a train from Manchester at 6:00 would presumably be at Heathrow around 8:30. A 90 minute minimum connection time would mean that they could catch a flight out at 10:00. So passengers from Manchester could not interline onto a flight leaving Heathrow before 10:00 in the morning.

Realistically, this rules out relatively few destinations – a quick check shows that passengers would not be able to fly direct to Detroit or on a day flight to Johannesburg, for example.

London is Manchester airport's largest flow. While the loss of much of the Heathrow traffic would not be good news for the airport, it is considered likely that a high speed train service would not seriously affect the distinct sub-markets between Manchester and both Gatwick and London City Airport.

5. Could the Heathrow Express tunnels be used?

While the use of the Heathrow Express tunnels for HS2 to Heathrow is superficially attractive, issues needing resolution include capacity, geography and loading gauge.

Capacity

At the moment the line between Airport Junction (the junction with the GWML) and the central terminal area is used by six trains an hour each way. There are four Heathrow Express and two Heathrow Connect trains, with a further two trains an hour shuttling between the CTA station and Terminal 4. There are plans to extend these two trains to and from Paddington (increasing the service between Airport Junction and CTA to eight trains/hour) in the short term: in the long term Heathrow Connect trains are expected to be replaced by Crossrail trains.

There are two important track layout constraints.

> There is a single-line section between the central terminal station and terminal 4.

> The Relief Lines between Paddington and Airport Junction are used by Heathrow Connect: the route from the Relief Lines at Hayes to the airport uses part of the London-bound track for airport-bound trains. This is safe, with modern signalling, but a significant constraint because a London-bound train cannot use that section of track until the airport-bound train has cleared it. This constraint is likely to be removed by works associated with the Crossrail project.

Trains using the Heathrow Express tunnels are multiple units, with good acceleration and braking characteristics. Indeed, the Heathrow Express units were designed so that, while they only have a maximum speed of 160 km/h, they can get from London to Airport Junction in the same time as the 200 km/h InterCity 125 trains with which they share the line. The latter have a higher top speed but less acceleration.

In general, mixing trains with different characteristics on the same piece of track reduces the capacity of the line.

Geography

Plans for Heathrow Express to serve the future Terminal 6, to the north of CTA, are uncertain at the moment, so it is difficult to say how this would impact on the situation. The terminal is likely to be north of the A4, just east of the existing M4 Spur (which is likely to be moved further east as part of the Terminal 6/Runway 3 proposals).

One possibility is a new station between the A4 and the M4 Spur roads, with a moving walkway or people-mover to the terminal.

A low-cost alternative is a station on the site of the former Heathrow Junction station, immediately north of the tunnels under Heathrow and significantly further from the new terminal.

For optimal connectivity, it would probably be best for any new service at the airport to serve terminal 5. This is initially to be the terminus of the Airtrack trains to south and south-west London, although ultimately Airtrack may be projected through CTA to Terminal 6.

If the service did stop in the central terminal area, a new station (possibly beneath the Heathrow Express station) would probably be necessary. The present station only has two platforms, and these are only long enough for a train of nine 23 metre vehicles.

The area east of Airport Junction is generally built up, so it is quite difficult to see any other site where a junction to a new tunnel could be. Possibilities exist in the Southall/West Ealing area. The junction would have to be grade-separated (to maintain track capacity): it would be a substantial piece of engineering. The line would need to be in tunnel by the time it crossed the M4 motorway, a kilometre to the south, so a junction significantly east of Airport Junction would probably need a dive-under rather than a flyover.

A further complication is Crossrail, planned to be completed by 2017.

One of the Crossrail issues may be platform screen doors. A report in April 2009 said that all underground Crossrail platforms would have platform screen doors: it is not known whether or not this means retro-fitting them to the Heathrow stations (difficult but not impossible, as has been shown in Hong Kong where retro-fitting has been done).

Clearly, these doors have to align with the doors of the carriages – which imposes a fairly standard door configuration on trains using those platforms[7]. A typical InterCity carriage has doors at the extreme ends: Heathrow Express and Heathrow Connect have four sets of doors (two sets each side). These are at one-third and two-thirds the way along each coach. The configuration of Crossrail carriages is not yet certain, but they will certainly need to be designed for speedy loading and unloading to ensure maximum use of the central London tunnels and will therefore probably need at least six sets of doors in each car – three sets on each side.

Loading gauge

The HS2 proposals assume double-deck – duplex – trains. These could not be accommodated in the Heathrow Express tunnels.

---

[7] Experience from Hong Kong shows that this is not an absolute requirement. Under special arrangements both Airport Express trains (with doors at one-third and two-thirds along each coach) and the high-density Lantau Line trains (with 4 sets of doors to each car) can use the AsiaWorld Expo station, which has platform screen doors aligned for the Airport Express trains. The acceptability of something like this to the UK rail safety authorities is uncertain.

Crossrail is being built with 6 metre diameter tunnels, compared with Heathrow Express's 5.7 metres: London Underground tunnels are 4.5 metres.

6. Cargo

The cargo area of the airport is on the south-west side, to the west of Terminal 4.

The EuroCAREX project is creating a network of rail-connected cargo terminals at airports – notably Paris Charles de Gaulle, Lyon St-Exupéry, Amsterdam Schiphol and Liege. The proposed site of the London terminal is to the east of the city, on the present HS1 line. These terminals are to be served by high speed trains, using the international high speed network.

There could be an opportunity to connect Heathrow's cargo area to the high speed line – and thus to the national and international rail network – at the expense of more tunnelling. The business case for this would be difficult to make, although much air cargo goes by road between Heathrow and places like Newcastle and Edinburgh.

7. Other resources

HS2 is generating a substantial and growing bank of literature.

For more on the Greengauge21 proposals, see
http://www.greengauge21.net/

Arup's Heathrow Hub is discussed on
http://www.arup.com/arup/newsitem.cfm?pageid=11243

The web-site of the 2M Group is www.2MGroup.org.uk. Other material is on
http://www.wandsworth.gov.uk/NR/rdonlyres/eyizqg7f2ngvzdldnpciw6ijoi7
ojobl4ttvlrfgfahtnta5k6md7multfjeirgyxriubweovu6atf3u5sbaorcqdob/2M+Hi
gh+Speed+Rail+Booklet.pdf

The views of the HS2 organisation can be seen on
http://www.dft.gov.uk/pgr/rail/pi/highspeedtwo/hs2remit/letter.pdf

A Department for Transport report was published in January 2009 as
"Britain's transport infrastructure: high speed two", and is available on
http://www.dft.gov.uk/pgr/rail/pi/highspeedtwo/

Steer Davies Gleave did a study of high speed rail in Great Britain for the
Strategic Rail Authority in 2001. This showed that the business case for a
north-south high speed line was good, and was improved by a Heathrow
connection.

Also relevant are

- the two reports following studies Steer Davies Gleave
  undertook for the European Commission in August 2006 – "Air
  and rail competition and complementarity" and "Air and rail
  competition and complementarity: case study report";

- the reports of the Rail Air Intermodality Facilitation Forum
  (RAIFF);

- "Adding capacity at Heathrow airport" by Moshe Givoni and
  David Banister, Transport Studies Unit, University of Oxford;

- "Ground Access to Major Airports by Public Transportation",
  ACRP Report 4; and

- IARO's report 11.08: "Case studies in cooperation between air
  and high speed rail".

8. Conclusions

Construction

At the very least, the construction of a third runway and terminal 6 at the airport could be an opportunity for work on intermodal infrastructure too. Planning consent for Terminal 5 was conditional upon significant improvements to public transport to Heathrow: it is likely that consent for Terminal 6 and Runway 3 would have similar conditions.

The three options

Of the three options, the Hub is probably the lowest cost. It has the least advantages to airport passengers but the most to non-airport passengers. It would need a fast and highly reliable automated people mover to connect to the terminals, unless Heathrow Express, Heathrow Connect and Crossrail could fulfil this function.

The Wye could be achieved at medium cost, but is the least attractive to non-airport passengers because it would extend their journey time more than the other options. It probably causes more railway operating problems than either of the other options. It is notable that there are fewer examples of this type world-wide than either of the others. Also interesting is the fact that a study a year ago by the Belgian infrastructure authority Infrabel of options for a rail connection to Charleroi airport deliberately did not look at a wye option, but only a hub station on the northern boundary or a tunnel under the airport. The very few examples of the Wye option may be indicative of its problems outweighing its advantages.

The Loop is probably the most expensive. It is likely to be the best for air passengers and therefore likely to be more used by them than other options. International examples of this type of station show substantial amounts of railway infrastructure, demonstrating that this option needs a substantial and expensive tunnel.

Use of the Northolt line from Old Oak Common for HS2 is probably easier and cheaper than new infrastructure west of Heathrow. It would, however, be more difficult to connect to Heathrow.

Demand

The level of demand is a key issue. How many people want to use such a connection, and where is the UK end of their journey? Will enough want to use a high speed connection into Heathrow for it to be viable?

To some degree this will depend on the level of service, its speed, reliability and convenience. Will it meet peoples' needs?

That said, it does seem perverse to plan a new railway close to Heathrow without actually planning to serve it.

IARO's Air/Rail conferences and workshops

Copies of the published reports of the earlier workshops are available price £250 (free to IARO members). Papers presented at more recent workshops are available on CD-ROM at the same price.

Workshops are very focused, dealing in detail with a restricted number of key issues, and complement the regular Air Rail Conferences. Workshops and conferences (with site visits) have been held as follows.

> 1993 - Zürich
>
> 1994 - Paris
>
> 1996 - London (Heathrow Express, Stansted Express)
>
> 1997 - Oslo (Airport Express Train)
>
> 1998 - Hong Kong (Airport Express Line)
>
>   - Frankfurt (with the AIRail station and the Cargo Sprinter)
>
> 1999 - Workshop 1: Berlin (the Schönefeld link)
>
>   - Copenhagen (the Øresund Link)
>
> 2000 - Workshop 2: Milan (Malpensa Express)
>
>   - Paris (plans for CDG Express)
>
>   - Washington (Baltimore-Washington International Airport)
>
> 2001 - Zürich airport: Air rail links - improving the partnership
>
>   - Workshop 3: Madrid (and its airport rail links)
>
>   - London Heathrow (Heathrow Express)
>
> 2002 - Workshop 4: Amsterdam, for railways serving airports but not as their main job - "Help - there's an airport on my railway".
>
>   - New York (the Airtrain projects)
>
> 2003 – Workshop 5: Barcelona. Today's design and funding issues for airport railways
>
>   Frankfurt (The AIRail project)
>
>   Workshop 6: Newark. Practical air rail intermodality
>
> 2004 – Workshop 7: Oslo. Leisure passengers – a market for airport railways.
>
> 2004 - Brussels (Thalys:Air France code-share)
>
> 2005 – Chicago (Chicago's future in an era of successful air-rail intermodality)
>
>   - Shanghai study tour
>
>   - Workshop 8: Edinburgh. Security on airport railways.

2006 – Workshop 9: Baltimore (BWI). Security on airport railways.

- Regional meeting 1: Stockholm

- Workshop 10: Marketing and ticketing innovations (e-air-rail) Düsseldorf

- Regional meeting 2: Kuala Lumpur

2007 –

- Los Angeles: Air/Rail East/West

- Baltimore: The seamless journey

- Vienna (Wien): Communications.

2008 -

- London Gatwick. One-day conference on ticketing

<hr />

Planned workshops and conferences

Please note that in future, it is planned to have IARO events in mid-May and November each year

2009

- June – Hamburg and site visit to the Airport S-Bahn
- October – Vancouver: successful light rail to airports

2010

- May – Amsterdam and the HSL-Z
- July – regional meeting Hong Kong
- October – Lyon: regional rail to airports

Details are available from IARO, or on www.iaro.com: you can sign up for details of future events in different parts of the world on www.iaro.com/events.htm

Future plans are, of course, subject to change.