UK Ultraspeed 500km/h ground transport for Britain

Welcome to UK Ultraspeed, the strategic transport network designed to transform the economic geography of Britain with 500km/h (311mph) intercity travel.

This factbook provides information on the Transrapid maglev (magnetic levitation) system which Ultraspeed will use and on how it will be deployed to create both North:South and East:West ultra high speed links with a single trunk route.

London to Birmingham in 30 minutes.

Heathrow to the brownfields of the North East in less time than it currently takes from Heathrow to Canary Wharf.

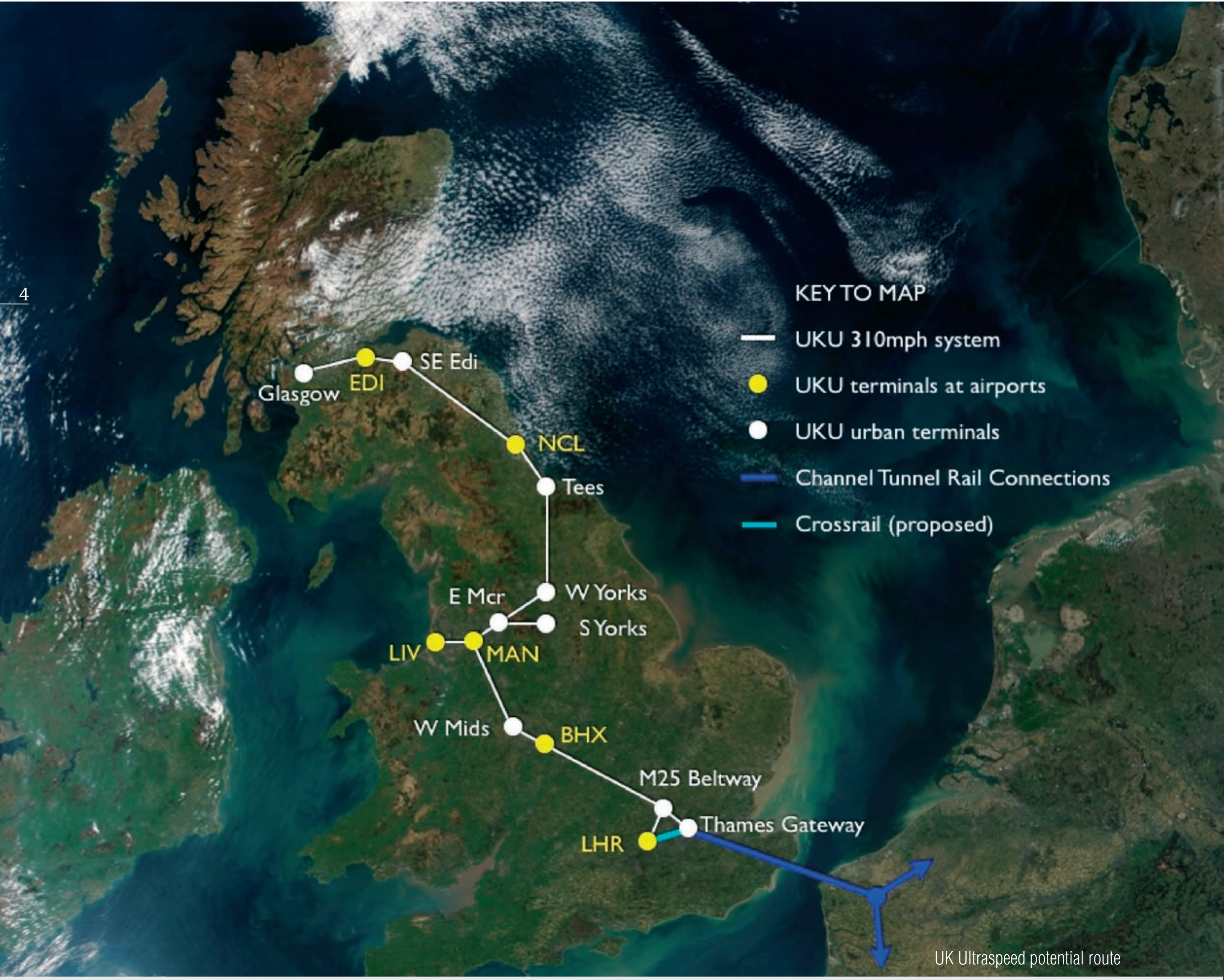
All the major cities of the English North linked by a journey of less than an hour from Tyneside to Merseyside.

Scotland's central belt tightened by a journey of only a quarter of an hour from Glasgow to Edinburgh.

These are some of the transformations UK Ultraspeed can deliver. This factbook presents data on the demand and operational economics underpinning the viability of the system, and on the means of constructing, financing and legislating for Ultraspeed.

Welcome aboard.

Alan James
Project Leader
www.500kmh.com



UK Ultraspeed potential route

What is UK Ultraspeed?

UK Ultraspeed is a proposed new national ground transport system, designed to drastically reduce journey times between major cities in Britain by operating at speeds of up to 500km/h (311 mph).

What technology is used by UK Ultraspeed?

UK Ultraspeed uses the German Transrapid magnetic levitation (maglev) system. Transrapid is the only ground transport system in the world certified to carry passengers in regular commercial service at speeds up to 500km/h.

The world's first Transrapid maglev to enter revenue service commenced public operation in Shanghai, China on 1 January 2004. The system connects Shanghai with its remote Pudong International Airport. Units conveying up to 600 passengers depart every few minutes. Millions of passengers have made the 267mph journey, which takes eight minutes. By car, the same journey can take up to an hour.

UK Ultraspeed indicative journey times

Origin	Intermediate Calling Points	Destination	Approx Journey
London or Heathrow (LHR)	-	M25/M1 Park & Ride	10 mins
London/LHR	-	Birmingham	30 mins
London/LHR	Birmingham	Manchester	50 mins
London/LHR	Birmingham, Manchester	Liverpool	60 mins
London/LHR	Birmingham, Manchester, Leeds, Teesside	Newcastle	100 mins
Newcastle	Teesside, Leeds, Manchester	Liverpool	60 mins
Manchester	-	Liverpool	10 mins
Manchester	-	South Yorkshire	15 mins
Glasgow	-	Edinburgh	15 mins
Glasgow	Edinburgh,Newcastle,Teesside, Leeds, Manchester, Birmingham	London/LHR	160 mins
Edinburgh	-	Newcastle	35 mins

Transrapid unit on maglev guideway

Who is developing UK Ultraspeed? What work has already been done? What happens next?

UK Ultraspeed is a British-led project, developed with the full support of Transrapid International, the Joint Venture between the German multinationals Siemens and ThyssenKrupp, who own the maglev technology. The Ultraspeed team first assembled in 2002 under Project Leader, Dr Alan James. Bringing together Transrapid technology specialists with UK experts in transport economics, engineering and project finance, the team conducted a detailed £2m pre-feasibility study during 2003 and 2004.

Following the exceptionally positive reception for the team's proposals and pre-feasibility results, the UK Ultraspeed Project Development Body was formed in 2005, Seeking always to work in partnership with Government and the project finance community, the objectives of the Body are:

- to help define the project in detail, to maximise its benefits for Britain;
- to help refine the project through definitive studies of its implementation in Britain; and
- to help create the mechanisms that will be required to build, finance and operate Ultraspeed in Britain.

The study concluded that ultra high speed intercity ground transport is technically and financially viable in the United Kingdom

The information presented in this Factbook is distilled from:

- the technical expertise derived from the research and development of Transrapid in Germany;
- the practical experience of the world's first ultra high speed maglev system in China; and
- the results of the pre-feasibility study in Britain;.

Although Ultraspeed has been designed on demand-first principles, this Factbook leads with an introduction to the Transrapid system, in order to familiarise British readers with the key principles of maglev technology, before then turning to our proposals for its application, as UK Ultraspeed, in the specific economic, geographic, environmental and transport context of Britain.

The UK Ultraspeed team for the pre-feasibility study

Company	Area of Expertise	Function
Expert Alliance	Project leadership & strategy,communications, political/policy liaison.	Strategic brief for the system, combining issues of UK economic competitiveness and regional development with strategic transport needs.
The Railway Consultancy	Market demand analysis, ridership forecasts and demand-led route model.	Developed the brief by detailed analysis of demand for an Ultraspeed network, taking into account origin: destination pairings, access, modal shift and abstraction/competition issues, peak traffic flows etc. Defined a network and timetable to meet this demand.
Transrapid International (Siemens & ThyssenKrupp)	Maglev technology, preliminary specification, integration and costing of maglev elements.	Responded to this initial requirement by defining all Transrapid technology elements needed to deliver the system. Simulated the entire network then supplied preliminary cost estimate for maglev elements.
Faithful & Gould (Atkins Group)	Project & Cost Management, Engineering.	Cost estimation and preliminary scheduling for all design, engineering & construction works required to deliver the system specified, at generic level by Transrapid, in the specific context of the UK. Produced combined estimate of these costs and all maglev elements.
Stephen Syrett	Project Finance & PFI.	Based on experience of leading other major infrastructure projects to financial close (including recently the HSL Zuid High Speed Line for the Dutch Government), developed PPP model to provide basis for future negotiation with public and private sector funders of the project.
Norton Rose	Legal & Planning.	Taking all the above intro account, provided legal advice on the Hybrid Bill mechanism required to enable Ultraspeed to be empowered, procured, financed and delivered.

The study workflow ensured that UK Ultraspeed was founded on demand-led principles. Technology and engineering are developed in response to a route model based on a clear demand analysis and on ridership forecasts derived from it. Ultraspeed is not a technology-led project. It is driven by demand and shaped by the clear requirement for improved strategic transport capacity in the UK.

What is Transrapid maglev and how does it work?

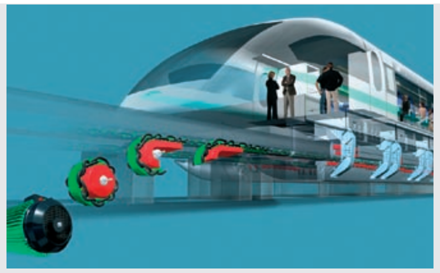
Ultraspeed uses Transrapid magnetic levitation, not rail, technology. This leapfrogs the much slower (300km/h) high speed rail systems by which many of Britain's competitors will be constrained for the next 100-150 years.

Transrapid is not a train, it does not have wheels and it does not run on rails. It is a completely new transport system. It uses electro-magnetic force to levitate passenger carrying vehicles above a guideway, to steer them along it and also to propel them at cruising speeds of up to 500 km/h (311mph).

Transrapid is the product of a decades-long strategic R&D effort by German industry and State partners. Tested to aviation standards under the most rigorous certification programme ever applied to ground transport, Transrapid is the only system in world the safety-certified to carry passengers at up to 500km/h on the ground.

In common with all Transrapid systems, Ultraspeed consists of three main elements, all of which are fully integrated with each other.

1



A fixed guideway housing a long stator linear motor. This can be built at ground level, or elevated up to 20m above the ground, thus passing over existing infrastructure without complex and costly civil engineering.

2

Transrapid vehicles, comprising up to 10 sections, which are capable of seating up to 1,200 passengers in total, although around 840 passengers per vehicle will be a UK norm. The vehicles levitate above the guideway and are steered along it by electromagnetic 'cushions'. They are propelled and braked by variable electrical current passed through the linear motor.

3

A highly automated Operational Control System [OCS]. This engineers in levels of safety and reliability which are impossible to achieve in rail, air or road transport. The OCS constantly monitors every vehicle's speed and position and adjusts propulsion power supplied through the guideway to ensure that every vehicle operates at the prescribed speed for each route section.

The guideway and its associated vehicle positioning system combine the critical functions of guidance, power supply, operational control, signalling, and safety monitoring into one holistic and highly automated failsafe system. This integration engineers out most of the human and system-fragmentation factors which cause accidents and delays in rail, air or road systems.

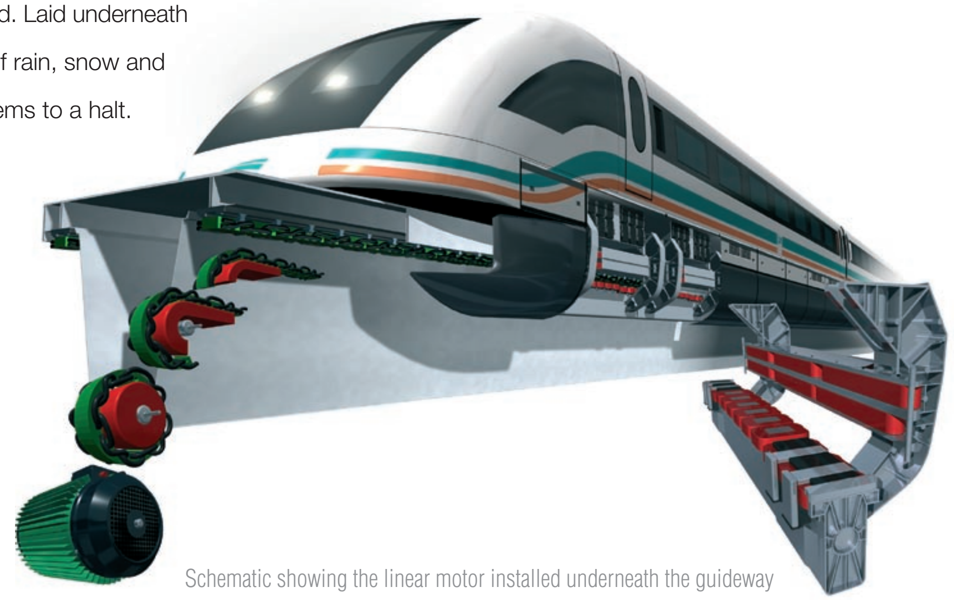
Transrapid is proven in daily service. The world's first commercial Transrapid route opened in Shanghai in January 2004 and has since carried millions of passengers, typically operating at 99.98% availability.

99.9%

availability

The linear motor

The heart of the Transrapid system is the linear motor. This is most easily envisaged as a traditional rotating electric motor whose stator coils have been unrolled and laid lengthways along the underside of the guideway. The linear motor is installed in sections and extends the whole length of the guideway: around 800km Northbound and 800km Southbound in the case of Ultraspeed. Laid underneath the guideway, it is immune from the effects of rain, snow and leaves which can bring other transport systems to a halt.



Schematic showing the linear motor installed underneath the guideway

12.11. 2003
World record
501 km/h
311 mph

Every few minutes Transrapid vehicles in China convey up to 600 passengers at 431km/h (267mph) and pass at closing speeds in excess of 800km/h (500mph).

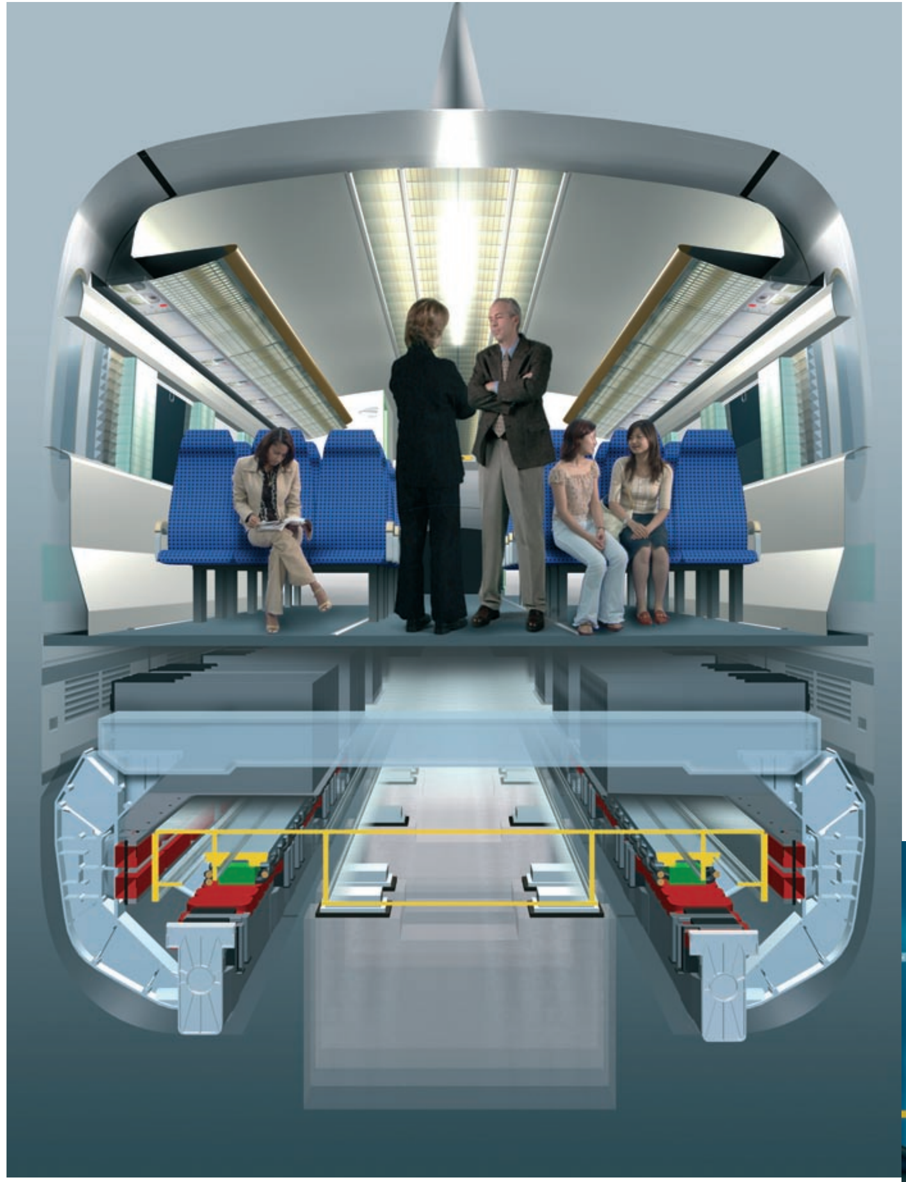
On 12 November 2003, a Shanghai Transrapid carried its passengers to a new world record for standard-specification ground transport vehicles: 501km/h (311mph). Maximum speed is not used in daily service due to the relatively short route length of 30km (19 miles).

With the linear motor in the guideway, there is no motor in the Ultraspeed vehicle itself, which means no polluting exhaust, no engine noise, no vibration.

The guideway itself is the motor. Transrapid vehicles are propelled along it by the electrical current which passes through it. Their acceleration, cruising speed and braking is controlled by the frequency of the current supplied to the linear motor by the operational control system.

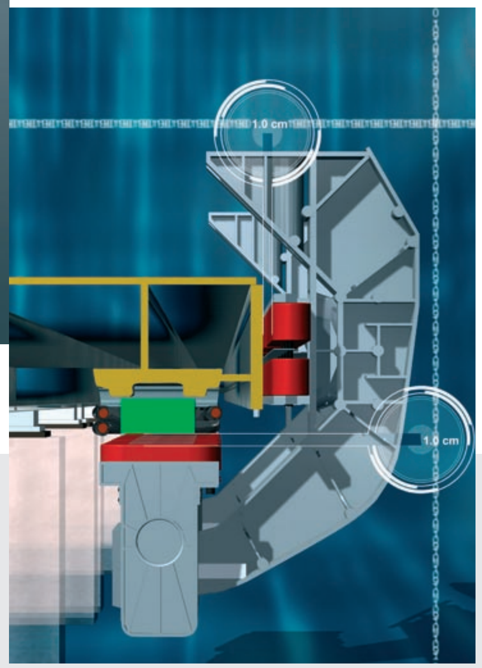
Transrapid vehicles do not sit on the guideway like a train, they wrap around it – making derailment impossible.

The guideway itself is the motor



Schematic of Transrapid levitation and guidance magnets (shown red) on underframe wrapping round the guideway. The linear motor is housed in the stator pack under the guideway (shown green). The levitation magnets on the bottom of the underframe are attracted up towards the stator pack when it is energised, thus levitating the entire vehicle. The guidance magnets, mounted laterally, steer the vehicle along the guideway.

Levitation magnets are mounted on the underframe of the vehicle. These are attracted upwards towards the guideway, but never make physical contact with it. Guidance magnets are mounted laterally on each side of the underframe. These steer the vehicle along the guideway – again they never physically touch it.



Close-up of levitation and guidance magnets (shown red) wrapping round the guideway. This schematic also shows the one centimetre separation gap between the vehicle and the guideway. This is monitored and adjusted several thousand times a second by on board sensors and the Operational Control System to ensure both safety and smoothness of ride.

Integration of guideway, vehicles, propulsion, operational control and safety systems

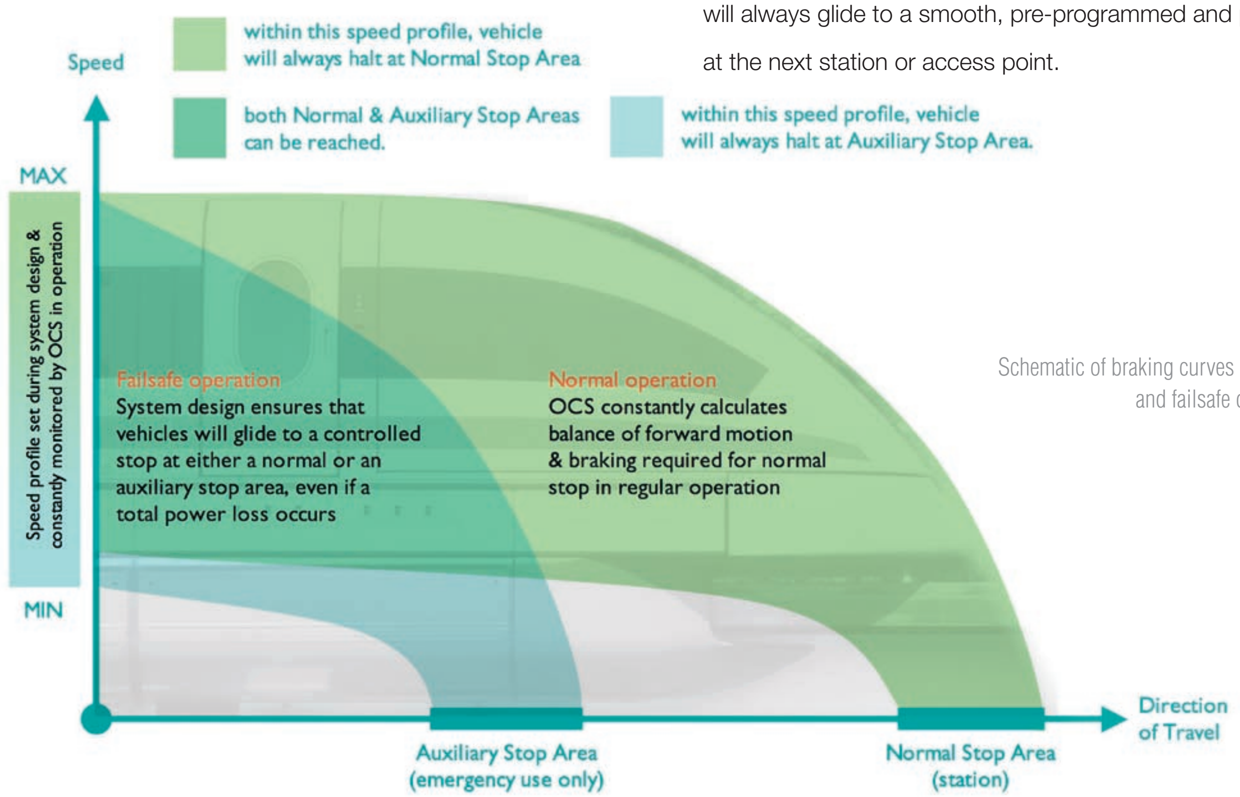
Transrapid does not require drivers. In common with all Transrapid systems, Ultraspeed will be operated by System Controllers in centralised control facilities. They oversee a highly automated Operational Control System [OCS], which directs every aspect of network operations. This engineers out human error, the predominant cause of accidents and disruption in other transport systems.

A key function of the OCS is to regulate the power supply for propulsion and braking.

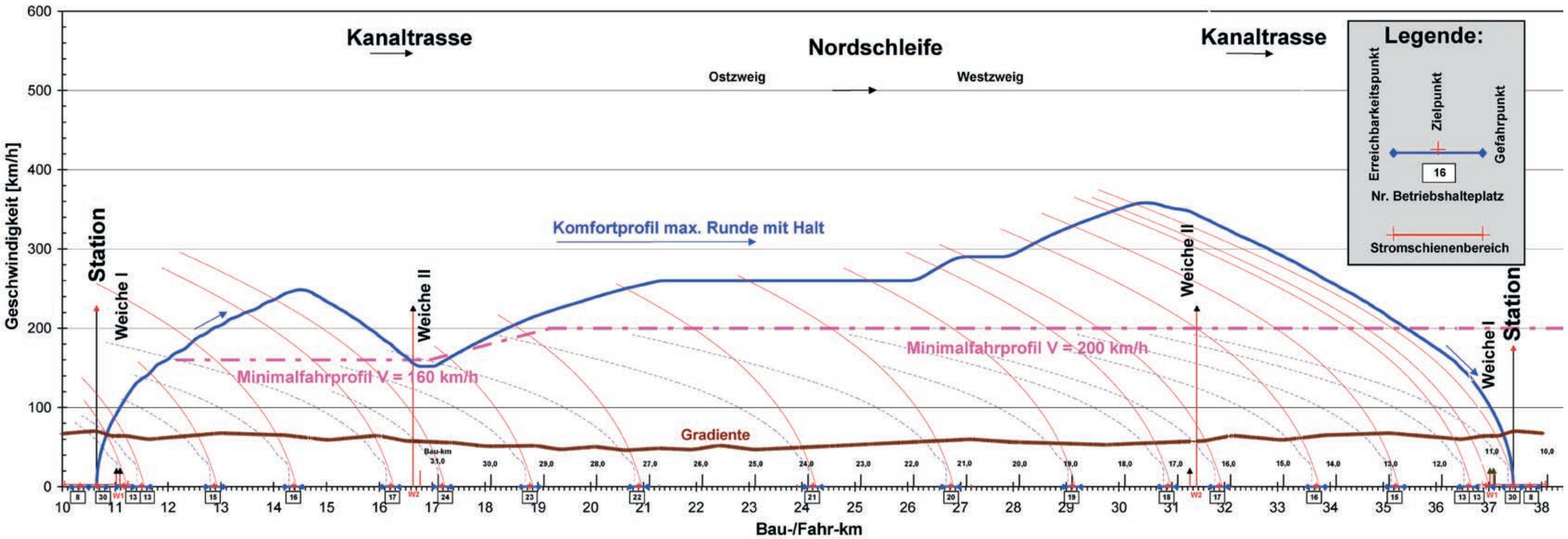
Once a vehicle is levitating, electric power is fed along the guideway to propel it. A travelling magnetic field passes through the linear motor, pulling the vehicle forward with it. The electrical frequency is precisely controlled to supply maximum power exactly where it is needed – for acceleration and hill-climbing zones for instance. Once cruising speed is reached – and 500km/h is attained in just over four minutes – precisely enough power is supplied to maintain exactly the right speed for each specific route section, bearing in mind its curves and gradients.

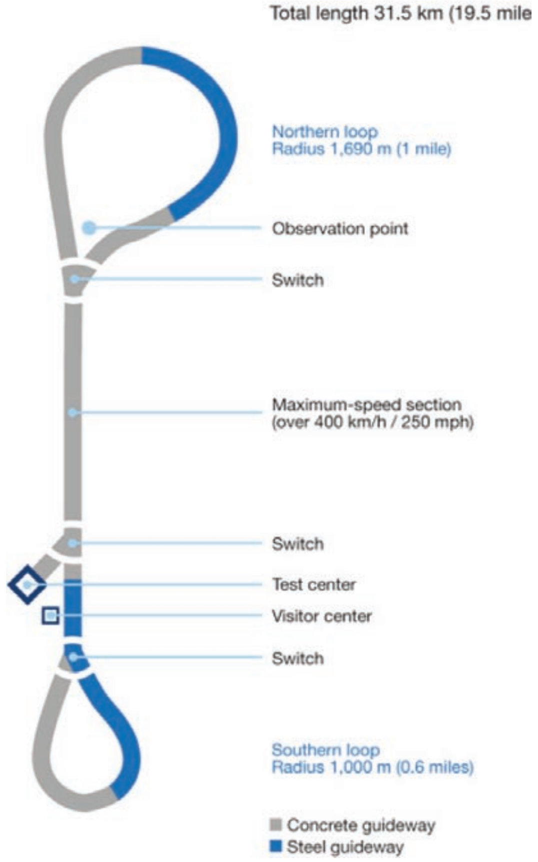
Braking is achieved by simply reversing the process, the travelling magnetic field is slowed down, thus retarding the vehicle and bringing it smoothly to a halt.

The power supply and all other safety-critical elements are designed to provide multiple redundancy – with several layers of back-up engineered-in. Naturally the system is designed to deal even with the massively unlikely event of total power failure. Backup power on board each vehicle will keep it levitating, so it will always glide to a smooth, pre-programmed and precise halt at the next station or access point.



Schematic of braking curves in normal and failsafe operation.





Minimum Speed Profile (Minimalfahrprofil) and Normal Operating Speed Profile (Komfortprofil) for a short 26km trip on the Transrapid test track in Emsland, Germany. The test track layout is also mapped opposite for ease of reference.

The principles of fail-safe design are transferred into practice on specific routes by designing the guideway and propulsion system holistically, taking into account gradients (Gradiente) and the locations of every station and Auxiliary Stop Area (Betriebshalteplatz). From these basic inputs a Minimum Speed Profile (Minimalfahrprofil) is defined, as is the speed profile which guarantees passenger comfort (Komfortprofil) when traveling over specific route sections between specific planned station stops. The Komfortprofil takes into account factors including curvature, guideway banking and g-forces exerted when cresting a hill. Both speed profiles are assured in normal service by the OCS feeding precisely the right amount of power to each section of the linear motor as the vehicle passes through that section. This is itself dynamically monitored in real-time by the OCS: on-board sensors, plus in-guideway and radio-based positioning systems feed back the exact location and speed of every vehicle several thousand times a second.

It is this integration – in design and in operation – of the Transrapid system which underpins many of its advantages.

Unlike a railway – where the track only provides guidance for trains, whilst a separate signalling system controls safety and yet more separate systems regulate the power supply – in Transrapid these are *one* system. The guideway is the track, signalling and power supply all in one. When these principles are applied to the design and operation of specific routes, the benefits become immediately apparent, as illustrated above.

It is possible to see Transrapid design principles in action by reading the map in parallel with the blue 'Komfortprofil' line on the graph.

Reading the blue line from left to right, it describes the speed profile of the vehicle as it departs Northbound from the station at the Visitor Centre. It accelerates past the first junction (Weiche 1) in the straight ahead position, then slows to 160km/h to take the second junction (Weiche 2) in the 'branch off' position. It then accelerates to around 270km/h and holds that speed through the eastern half of the Northern Loop (Nordschleife).

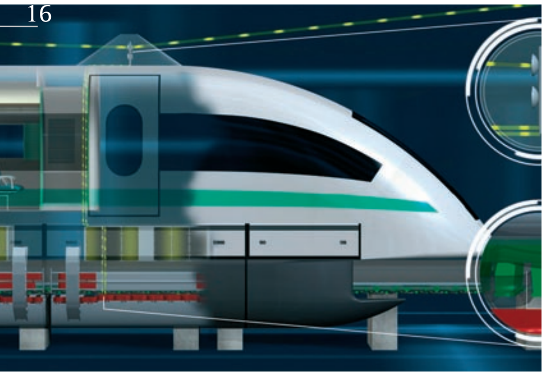
At the mid-point of the Nordschleife, as the vehicle begins its Southbound travel, it accelerates in two stages to a peak velocity around 360 km/h, then passes back through the second junction (Weiche 2), which is now set in the straight-ahead position. It is already decelerating to a complete stop in the station from which it departed.

The downward curves are the braking paths from the minimum and normal speed profiles required to come to a complete halt at either one of the Auxiliary Stop Areas (Betriebshalteplatz) or at the station.

With the OCS ensuring that the linear motor *always* propels the vehicle at *precisely* the correct speed for its *precise* location at *all* times, extraordinary levels of safety are achieved. Even if a total power failure occurs the vehicle will *invariably* glide to a controlled stop in a pre-planned location. Safety is further assured by feedback making the OCS instantly aware of any break in the guideway. In this unlikely event, vehicles in the affected area will again be brought to a controlled stop at a pre-planned location.

The integration of the operational control and power-supply functions produces significant safety benefits. Only the motor section in which the vehicle is actually travelling is powered up – with the next segment only switching on as the vehicle nears the section boundary, and so on, all the way along the route. The section behind each vehicle is switched off, so that it is physically impossible for the following vehicle to run into the one in front. As the speed increases, so the length of the powered-off section behind is increased to ensure the correct separation between services. This provides a higher built-in level of safety than even the most demanding ERTMS Level 3 EU specification for high speed rail systems – and such systems have proven impossible to retrofit over the UK's classic rail infrastructure.

A radio-based positioning system also feeds back to the Control Centre the precise location of every vehicle (to within a matter of centimetres) as well as its exact speed. This gives the OCS an unprecedented level of direct command and control over the network. Schedule, separation and speed are maintained with a degree of precision impossible in any other mode of transport.



Operational Control System: the precise location and velocity of every vehicle is controlled and monitored by the guideway and by a second, independent, radio-based positioning system. This controls speed, separation and schedule more precisely than any other transport system

The same safety-led design principles apply to the points at junctions. Bendable steel guideway sections are set to provide either a straight-ahead route – which can be taken at maximum speed – or a 'branch off' route, which necessitates slowing down to a lower speed. In setting a branch off route, the OCS feeds precisely the right amount of power to the guideway, so it is impossible for a vehicle to approach the junction too fast. When the points are actually being switched from one route to another, the preceding sections are completely powered down, so that no vehicle at all can approach before the route ahead is clear.

Transrapid vehicle passing points in the straight position

Transrapid vehicle approaching points in the curved position

Transrapid vehicles pass in Shanghai – closing speed over 860km/h (530mph)

Why has UK Ultraspeed selected the Transrapid system?

Transrapid is the most comprehensively integrated transport technology available. It has been designed and exhaustively tested to be not only the fastest ground transport system in the world, but also the safest. Engineered in Germany, under the world's most rigorous certification regime, and now proven in intensive daily operation in China, Transrapid is a major step forward in transport technology.

Yet the Ultraspeed project is not defined or driven by technology. The objectives of Ultraspeed are broader, to create a step change in capacity, competitiveness and sheer speed to:

- enhance Britain's environment;
- empower Britain's economy;
- transform Britain's transport.

UK Ultraspeed selected Transrapid because it delivers the best possible solution for Britain. The remainder of this Factbook looks in detail at how Ultraspeed proposes to deploy the Transrapid system to deliver maximum benefits for Britain.

UK Ultraspeed

500 km/h ground transport for Britain

Transforming Britain's Transport

UK Ultraspeed is not driven by technology. Transrapid has not been selected for Ultraspeed on the grounds of its technological or engineering advantages, powerful though they are. Ultraspeed has been designed to use the Transrapid maglev system because it is a compelling solution for Britain.

At the very fundamental level of basic geography, the distribution of Britain's cities is ideal for very high speed intercity ground transport. Britain has a significant number of very large conurbations which are separated by distances from around 50 to around 200 kilometres of relatively sparse population.

Where major centres of population lie too close together, such as Amsterdam/Haarlem/Rotterdam area, then very fast intercity transport simply does not fit with the population patterns. Where they are thousands of kilometres apart, such as the East and West Coasts of the USA, then flying is the most competitive option,despite the time penalty at each end for airport formalities and the link journeys from city to airport and vice versa. In Britain, though, basic geography ideally hits the 'sweet spot' for ultra high speed ground transport. Firstly, most journeys are long enough to exploit the maglev speed advantage over all other ground transport.Yet secondly, they are also mostly short enough for the inherent speed of air travel to be undermined by the time wasted by airport formalities, crowded taxiways and air traffic control delays which effectively triple the actual airborne time of short haul flying in the UK.

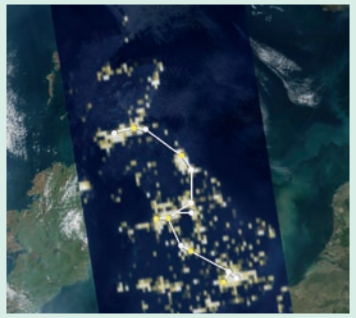
Furthermore, it is not just the distribution of Britain's cities that is relevant – it is also their sheer size. Not only do they lie an ideal distance apart to benefit from ultra fast connections *between* the conurbations, there are also large enough markets *within* the conurbations to support the intensive, rapid service Ultraspeed will provide. An international comparison between two routes of roughly the same length (around 300 km) illustrates the point.

Comparing the two satellite images illustrates it well: the UK has brighter, bigger and better-spaced conurbations than along major corridors in competitor countries – ideal pre-conditions for Ultra High Speed ground transport.

UK 300 km key population centres		Germany equivalent 300 km	
Greater London	7.1 million	Hamburg	1.7 million
West Midlands	5.3 million	no major midway centre	–
Greater Manchester	2.5 million	Berlin	3.4 million
	14.9 million		5.1 million

Source: UK 2001 Census & 2004 German Federal Government figures

The sheer speed of the Transrapid maglev technology – as opposed to 300 km/h traditional wheel-on-rail TGV style trains, let alone 'classic rail' or motorways – has another major advantage in UK geography. Ultraspeed can offer journey times that are faster than air travel between most of the major centres of population along Britain's North:South spine, with a *single* main route.



This means that Ultraspeed is significantly more efficient and cost-effective than any other North:South strategic transport solution on the basic measure of the quantum of infrastructure required.

- The existing North:South motorway network is split into Eastern and Western corridors – the A1(M) and M1/M6 routes, supported in the West by the M40/M42 alternative to the West Midlands.
- The existing North:South rail network is split into East Coast and West Coast main lines.
- Both the rail and motorway routes are linked by East: West routes across the Pennines – the M62 and various rail options between the Northwest and Yorkshire.

So where rail and road each require *three* routes to serve the major centres of population, Ultraspeed will serve most of these centres with *one* mainline system.

This fundamental aspect of the Ultraspeed case is also strong when compared with potential High Speed Rail solutions. Recent work by WS Atkins indicates that, again, *three* TGV-style alignments would be required to deliver attractive journey times to the North West, Yorkshire and the North East. This is simply a factor of the slower speed (300 km/h) of wheel-on-rail technology.

Ultraspeed delivers

North:South *more comprehensively* than high speed rail

East:West *for no additional cost*

both N:S and E:W with *more and faster* journeys

both N:S and E:W with *less* total infrastructure

The Atkins best-case 'Option 8' scenario (the only scenario offering a national set of journey times remotely comparable with Ultraspeed) illustrates the point. For comparison's sake we take the TGV style train Atkins envisage running in 85 minutes on a new direct *Ligne a Grande Vitesse* from London to Leeds and contrast it with Ultraspeed between the same points.

Comparative indicative journey times and stopping patterns

500 km/h Ultraspeed		300 km/h TGV	
London	0 mins	London	0 mins
M25 Parkway	10 mins	serves no intervening major markets	–
Birmingham Hub	30 mins		–
Manchester Hub	50 mins		–
Leeds	70 mins		85 mins

WS Atkins High Speed Line Study for SRA/DfT: Option 8 foresees a London-Birmingham alignment, which then diverges into an eastern branch to Leeds and the North East and a western branch to the North West, which itself then again diverges in the Potteries into Manchester and Liverpool branches.

So not only is Ultraspeed faster end-to-end, but the sheer speed of maglev creates more connections between more places than high speed rail is capable of delivering.

Because the proposed wheel-on-rail route splits into separate branches, several Ultraspeed journeys are simply not possible on even the 'best case' TGV-style network. These include the vital 'Northern Way' backbone needed to create a globally competitive super-region from the three regions of the English North, as well as several rapid East-West connections between key city-regions within that area. The table below illustrates.

Route	Ultraspeed journey time	
Tyneside – Teesside – Leeds – Manchester – Merseyside	60 mins	all these journeys are not possible on the 'best case' TGV-style rail solution
Leeds – Manchester	15 mins	
Merseyside – Manchester	10 mins	

In short, wheel-on-rail as currently proposed only answers a North:South brief. Ultraspeed can deliver a better and faster North:South solution whilst *also* providing a strategic East:West link across the North of England. Yet the 800km Ultraspeed network would be up to 200km *shorter* overall than the 'Option 8' high speed rail proposals. Using the Channel Tunnel Rail Link precedent of £48 million per route km, this would indicate that just the *additional* TGV-style infrastructure required would cost up to an *additional* £9.6 billion.

High performance enables Ultraspeed to meet strong demand

Basic economic geography tells us where major markets are *located*, detailed modelling was carried out at pre-feasibility stage to predict how these markets will *behave* when Ultraspeed transforms connections between them.

Detailed forecasts for Ultraspeed were produced by breaking down markets which could be served by the route into origin:destination pairs. For example, Sunderland to Reading is one such pair: the passenger has a choice of rail, air, road or Ultraspeed for inter-city transport between a North-East hub and a London hub *and* choices regarding the 'feeder' journey from the origin point to the Northern hub, as well as the 'distributor' journey from the London hub to the ultimate destination.

For illustration, the private car can accomplish the journey door-to-door with no 'modal shift' between different types of transport, but will take up to eight hours. By contrast, an Ultraspeed journey will require the passenger to use private or public transport to reach one of the North East terminals and again for the distributor journey from the Heathrow Ultraspeed terminal, but the total trip will take only around three hours overall.

By splitting a journey into its component parts, the methodology thus fully takes into account the impacts of modal shift, speed and convenience on passenger choice. In essence, the model balances the positive incentive of speed against the disincentive of inconvenient modal shifts. The model also takes into account competition with, and likely abstraction from, existing modes of transport and makes prudent forward assumptions for key factors such as the cost of travel by each mode and the impact of increasing congestion.

A hypothetical Ultraspeed timetable – based on technically feasible journey times – was then produced, so that the model would be able to reflect the 'shrinking of distance' caused by Ultraspeed's significantly increased speed and considerably reduced journey times. As an example, a portion is reproduced here, dealing with the route section between the English North East and London.

Sample indicative timetable used for demand modelling

From the North East							
Tyneside	dep.	07.00					07:35
Teesside	arr.						07:48
	dep.						07:50
W Yorkshire	arr.	07:26					08:06
	dep.	07:29		07:39	07:59		08:09
E Manchester	arr.			07:52			08:22
	dep.			07:54			08:24
From the North West							
Merseyside	dep		07:46			08:16	
NE & NW services merge							
Manchester Apt	arr.	07:46	07:56	08:01	08:16	08:26	08:31
	dep.	07:49	07:59	08:04	08:19	08:29	08:34
Potteries	arr.			08:15			08:45
	dep.			08:17			08:47
B'ham Internat.	arr.	08:09	08:19	08:29	08:39	08:49	08:59
	dep.	08:12	08:22	08:32	08:42	08:52	09:02
Junction point							
Heathrow	arr.	08:39			09:09		
London Hub	arr.		08:50	09:00		09:20	09:30

It should be stressed that this timetable is indicative, designed only to serve as a basis of demand modelling at pre-feasibility stage, although the journey times it includes are perfectly feasible. However, a number of key features of the Ultraspeed service proposition are already clear at this stage:

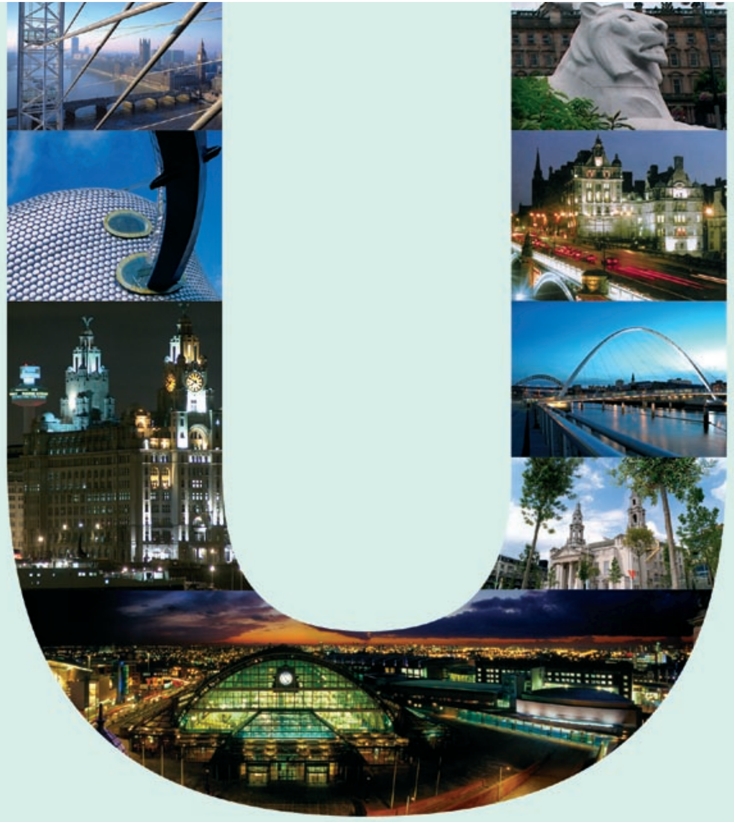
- 10 minute frequency on the core route section south of Manchester.
- Regular 'clockface' service pattern – every ten minutes at the same minutes past the hour at Birmingham, with the pattern carried back northwards up the route as far as possible.
- Manchester Airport as Ultraspeed's key hub, through which Ultraspeed's North:South and trans-North services pass.

The sample timetable is also simplified for presentation purposes. It does not, for instance, show the full Tyneside – Merseyside East: West 'Northern Way' service that would 'fill in' between North:South paths over the Northern England route section. Detailed work during the pre-feasibility phase refined the service pattern in the light of demand and technical issues. Further refinement will also be undertaken during the Project Development Study phase.
Key issues include:

- Inclusion of an M25 'Beltway' stopping point to enhance access to North London and the Home Counties.
- Integration of Anglo-Scottish services.
- Integration of intensive shuttle services in addition to intercity traffic on peak demand sections, or to join two major economic or transport poles into a single effective unit (Liverpool & Manchester Airports, for instance).
- Refining the balance between overall speed and the number and location of terminals, to make Ultraspeed both optimally fast and optimally accessible for the greatest possible number of passengers in the widest possible catchment areas.

Taking ongoing refinements and the total daily market for intercity travel between specific origin:destination zones into account, overall demand for Ultraspeed was forecast.
Sample results are shown here.

Key origin:destination pairs	Total Daily Trips	Ultra speed Trips	% market share
Glasgow – Edinburgh	14600	4800	33%
Tyneside - Greater London	4000	2600	65%
West Yorkshire – Greater Manchester	7500	2300	31%
West Yorkshire – Greater London	6200	1800	29%
Greater Manchester – Greater London	7500	3400	45%
West Midlands – Greater London	13000	5500	42%



Detailed 'link loading' analysis was then performed, to determine how many passengers would use Ultraspeed services between various points. This table shows, for example, that in a peak hour, 3,700 people are likely to travel southbound on Ultraspeed from a West Yorkshire Parkway terminal towards Manchester and points beyond.

Link Loadings (Southbound)	Peak Hour	Average off-peak hour
Glasgow	1800	750
Edinburgh Airport	2400	850
Edinburgh Parkway (A720/A1)	3200	1300
Newcastle Airport	3200	1400
Newcastle/Gateshead	3400	1600
Tees Valley Parkway	3400	1600
Leeds	3700	2000
West Yorkshire Parkway (M62)	3700	2000
Manchester East	2500	1300
Manchester Airport	2600	1400
Wolverhampton	2900	1600
Wednesbury	3200	1800
Birmingham Hub (International Apt & Rail Stn, M6/M42, NEC)	3800	2100
M1/M25 Parkway – Stratford	1600	1100
M1/M25 Parkway – Heathrow	1600	800

Clearly this number is made up of a proportion of passengers who are attracted by an Ultraspeed trip of only a few minutes over the Pennines to the Manchester area. Others will be travelling further, attracted by fast intercity journey times to the West Midlands and the London area. Still others will be using Ultraspeed to connect to international flights at Manchester, Birmingham or Heathrow airports.

In short, the single Ultraspeed system is doing many jobs, meeting a wide variety of passenger needs.

doing many jobs, meeting a wide variety of passenger needs

Fare levels

Ultraspeed revenue modelling projected off-peak 'entry-level' fares comparably priced with 'Saver' travel on rail or with budget air tickets. Finely graduated premium fare levels, whose supply will be optimised against demand by real time inventory control and yield management, will be available. These will offer increasing degrees of flexibility and access to Premier Class on-board accommodation.

Fundamentally, Ultraspeed will be accessible to all. The forecast *average* fare over *all* journeys on the entire system on the base-case projection is under £20. Shuttle fares will be available for as little as £5 between city pairs such as Liverpool – Manchester, Tyne – Tees and Glasgow – Edinburgh. Early-purchase *return* fares from the English North to London will be available for between £25 and £40. This already compares extremely favourably with the real cost of motoring from, say, Manchester to London and back, which the AA estimate at around £190 for a four seat family car – a figure which will increase substantially if road charging is introduced.

Ultraspeed envisages revenue sharing collaboration with airlines and their marketing alliances to create seamless integration of their international services with Ultraspeed feeder/distributor services into any of the airports on the route. Ultraspeed services could operate as full codeshares and as 'points earning sectors' in airline loyalty programmes. The precedent exists – the airlines have abandoned Paris-Brussels as a viable air sector and sell Thalys TGV journeys with airline flight numbers.

Total ridership

Taking all the factors influencing passenger behaviour into account, the 'base case' demand for Ultraspeed is forecast to be at least 40m passengers per year. It is expected that this baseline figure will be very significantly exceeded, especially as Ultraspeed will *itself* create *new* travel patterns that are simply too slow or impractical today. For the sake of prudent forecasting, however, this suppressed demand was not factored in to the baseline case.

Total revenue

On the exceptionally conservative base-case ridership projection, plus income derived from high-speed, high value freight (sch as postal and courier traffic) total annual income will be a minimum of £700m and will exceed £1bn per annum on the basis of reasonable assumptions regarding fares mix, yield management and the release of demand suppressed under current transport provision.

Operational efficiency

With no major moving parts, and no friction between vehicles and guideway, Transrapid has very low maintenance costs.

Whole-lifecycle costs for vehicle and guideway renewals are also considerably lower than rail. Highly automated failsafe operation also makes for very low staffing costs. The viability of Ultraspeed is thus underpinned by the fundamental efficiency of the maglev technology itself, as illustrated here.

Key Factor	Ultraspeed	Comparator
Total operations costs as % of total traffic revenue	±35%	Airlines: typically 90%+
Total drivers/pilots required to produce ± 30bn Available Seat Km (ASK) of UK domestic transport capacity	0	Airline/Rail/Coach *many thousands*
Total System Control staff required to cover full three shift operation of national system	3 control centres with max 46 staff	Rail: 1,000 signal boxes, *several thousand staff*
Total staffing costs as % of total traffic revenue	±8%	Budget airline: ±14% Full service airline: ±28%
Vehicle maintenance cost per ASK	±18p	Full service airline Passenger fleet: ±36p
Total maintenance costs per ASK (*full* costs for vehicles *and* infrastructure)	±36p	ICE Rail system: ±118p

Capital Cost

Results from the pre-feasibility study are presented below.

Capital cost of maglev elements

It is emphasized that costs are estimated to ±30% at pre-feasibility stage and are subject to refinement in subsequent studies. However, fully integrated design of Transrapid guideway and all its associated propulsion, control and switching sub-systems means that these can be estimated very precisely even at such an early stage. Similarly, tightly pre-designed operations and maintenance regimes mean that terminal, control centre and maintenance functions are known and the physical facilities needed to house them can be accurately scoped. Given this, early-stage Ultraspeed figures can be presented with a greater degree of confidence than would be the case with a similarly-sized major rail or road project. Significant variation would occur if, for instance, detailed studies recommended a different number of stations.

German	English	Result
Gesamtstreckenlänge •35% ebenerdig •65% aufgeständert •Einzelspur für Depot & IH	Total route length 35% at grade 65% elevated Single track in depots	800km 15km
Anzahl Haltestellen	Number of stations	16
durchschnittlicher Haltestellenabstand	Average distance between stations	50 km (min 8km; max 148km)
Höchstgeschwindigkeit	Maximum speed	500 km/h
Takt	Frequency (1 way) *mainline services only*	6 per hr M25 to Manchester 4 per hr north of Manchester 2 per hr north of Leeds
Anzahl Unterwerke	Number of substations	28
Anzahl H-Umrichter	Number of high-tension rectifiers	282 (power supply for main route)
Anzahl M-Umrichter	Number of medium-tension rectifiers	8 (power supply for depots etc)
Anzahl Fahrzeuge	Number of vehicles	30-36 each of 10 sections
Anzahl Weichen	Number of guideway points (switches)	79
Schiebebühne	Traversers (moves vehicles from track to track in depots)	4
Depot/IH-Anlagen	Depot/Maintenance facilities	4
Betriebsleitzentren	Operational Control Centres	3
Dezentrale Leittechnik	Decentralised control technology installations	62

Depending on final route layout and service pattern requirements, the total capital cost for the Transrapid elements specified above (again as a pre-feasibility preliminary estimate subject to refinement and confirmation by later studies) is in the range of £4.9bn and £5.4bn.

These figures exclude the fleet of gliding stock. The assumption driven by the demand model is that Ultraspeed vehicles will each consist of 10 sections (carriages in rail terms) capable of seating 700 in economy and 140 in premium accommodation – or up to a maximum of 1,196 passengers in all-economy configuration. Again depending on final route layout and service patterns, between 30 and 36 ten-section units will be required. With a preliminary estimate of £5.8m per section (again subject to refinement and confirmation by later studies) total fleet costs will be in the range of £1.7bn to £2.1bn. It is worth noting that the total fleet is only half the size that wheel-on-rail would need to provide similar transport capacity (greater speed means more intensive utilisation).

Capital cost of non-maglev elements

The pre-feasibility study then estimated (again to preliminary ±30% levels) the design, engineering, construction and associated capital costs that would be incurred when translating the Transrapid system specification into an actual built network in the specific geographic and construction market context of the UK. With the major exclusion of land acquisition plus other marginal items which cannot accurately be predicted at an early stage (development study costs, legal, parliamentary and planning fees, public consultation expenditures and third party compensation) Faithful & Gould estimated non-maglev elements in the range of £11.1bn and £14.4bn, again dependent on precise route alignment.

Combined total capital cost

Combining the pre-feasibility estimates for both maglev technology and generic project delivery elements, with the major exclusion of land, the total costs of building the Ultraspeed infrastructure (to ±30% pre-feasibility standards) range between £16.0bn and £19.8bn.

Capital cost per route km

The £16.0bn to £19.8bn range discussed above equates to a total capital cost per double-track route km (i.e. one northbound and one southbound guideway for one kilometre) of between £20m and £24.75m.

This compares favourably with the only available UK precedent, the slower, 300km/h, Channel Tunnel Rail Link high speed rail line through Kent and Essex to London. The total out-turn cost for this project, when it opens in full in 2007, is projected to be between £46m and £48m per double-track route km, *including* land. The CTRL benchmark implies a 'cushion' of between £21.25m and £28m per route km for land acquisition and the other marginal costs currently excluded from estimates.

45 times less land
than a three lane motorway

Additional comfort is provided here by the minimal land-take of the Transrapid system. Built elevated, to do so where environmentally appropriate as little as 2.1 square metres of land are required per linear metre of guideway (with the space underneath remaining usable for its original purpose). This compares with 7 or 8 times as much land-take for a high speed rail line and around 45 times more land-take for a motorway with two three-lane + hard shoulder carriageways (up to 96m^2 per linear metre). A final point relating to land take. In the North in particular, it is envisaged that much of the Ultraspeed alignment will run over brownfield land owned by the RDAs or other public sector bodies. Given the substantial public benefit generated by Ultraspeed, we assume that HMG will wish to see favourable land deals achieved in these areas.

Measuring benefits

Cost:benefit analysis is a vital tool in ensuring that a proposed investment delivers value to the public. Whilst these measures are typically used to evaluate projects that are fully or largely funded by the public sector – which is *not* the case with Ultraspeed – the project team positively welcomes scrutiny against a wide range of such metrics.

£2bn of economic benefit to the UK, every year, in journey time savings alone.

To give only one example, Ultraspeed delivers approximately £2bn of *annual* economic benefit to the UK, using DfT 'value of time' figures for journey time savings alone. As project development progresses, we look forward to further quantification of Ultraspeed benefits against such measures as congestion relief, emissions reduction and the 'strategic economic impact' metrics put forward in recent DfT/RDA joint work on *Surface Infrastructure of National Economic Importance*.

The 'Northern Way' foundation document quantifies a £29bn annual productivity gap between the North of England and the UK average. It also identifies strategic transport as the key intervention required to solve the problem. Ultraspeed will make a significant contribution in this domain by creating a more sustainable balance between London and the economies of the English North and Scotland. We look forward to dialogue with Government to define appropriate metrics for analysis of project benefits.

Project finance model

The pre-feasibility study concluded that a Public Private Partnership model would the best way to fund, construct and operate Ultraspeed in the specific conditions of the UK. PPP/PFI is the natural mechanism, taking into account, on the one hand, the solid commercial case for Ultraspeed, the system's inherent operational efficiency and cost-effectiveness and, on the other, its ability to deliver transport, regional economic development and national competitiveness benefits in the public good.

Pre-feasibility work recommended a PFI strategy with the following objectives:

- to minimise any direct UK Government borrowings and provide the best structure to allow the funding to be treated as outside the PSBR;
- to meet the required parameters of value for money and affordability; and
- to permit significant funds (both debt and equity) to be raised on attractive terms from the financial markets based on an agreed PPP model.

To achieve these objectives it is vital that the underlying financial and corporate structure and the related financial security package is appropriately structured and, secondly, that the project is phased into manageable sections. Phased delivery will:

- allow funds to be raised in manageable tranches to avoid impacting on the overall appetite of the financial markets;
- reduce the overall cost of finance by removing any perceived 'technology risk' early in project roll-out; and
- avoid any possible overloading of the construction market, thereby allowing a strong competitive process.

Distilling best practice from UK and international PFI deals, including the notable recent precedent of the 'High Speed Line Zuid' in the Netherlands, pre-feasibility analysis concluded that private sector franchisees competing to build and operate the system can be expected to shoulder all of the following key risks:

- costs of bidding and competitive process;
- technology design, delivery and commissioning;
- fund raising;
- construction and completion of the network;
- operation and maintenance of the system for a pre-defined concession period after construction; and
- hand over at the end of concession period.

Government would, of course, remain responsible for those elements which *only* Government can provide, such as the legislative process to enable construction and the definition and delivery of appropriate planning and environmental regimes. PPP rail projects worldwide have also demonstrated that, in the vast majority of cases, it has been either impossible and/or not cost-effective to pass patronage risk to the private sector on a competitive basis. With this in mind, the PFI model recommended by pre-feasibility work is based on an 'availability payments' structure. Under such a regime, the operator (or 'Nominated Undertaking' in Hybrid Bill terms) would receive payment on a regular and pre-defined basis for making the Ultraspeed system available and providing Ultraspeed service to rigorously specified and pre-agreed standards. It would be a condition of the contract that payments would only be made provided:

- that the system had been constructed and completed to pre-defined required specifications; and
- that, once the system is operational, a pre-agreed performance regime – including standards for frequency, punctuality and quality of service – continues to be met.

Failure to meet these requirements would lead to deductions from the availability payments and ultimately termination of the concession. The availability payments would be fixed (except agreed inflation factors) throughout the life of the concession as part of the competitive process. Such an availability payment structure has been used on major rail projects, including the recent PPP in the Netherlands where project finance was raised in the international financial markets without difficulty and on highly competitive terms.

Subject to confirmation during further study, precedent suggests that the availability payment structure could be treated as a form of current account expenditure, and not impact on the PSBR, as an availability payment is a form of contractual payment to pay for defined services (ie provision of the defined system and the commitment to operate and maintain the system over the concession period under an agreed performance regime). There are precedents for such an approach on the majority of major UK PFI infrastructure projects, such as the contractual arrangements under PFI hospital concessions where "usage" payments have been agreed on a similar principle to the proposed availability payment structure.

Value for money would be secured by a full competitive process for all generic elements of the project, whilst the unavoidably single-source elements of maglev technology and associated project IPR, for which all PFI bidders would submit 'level playing field' bids,would be subject to best value scrutiny. It should be noted that there would not be a requirement for any upfront grant, or payment, from the public sector as has been the case on some PFI light rail projects (eg Nottingham and Manchester tram projects). The availability payment stream from the public sector would be partially, and in the long term potentially fully, compensated by the patronage revenues as well as the other accruing economic benefits, as discussed elsewhere in this Factbook.

Based on the above, we are confident that the majority of the required debt and equity could be raised in the financial markets on competitive terms. In this connection, it should be noted that Partnerships UK state that, up to 2005, 689 PPP/PFI or similar type projects have been signed in the UK with a capital value of approx £44.175bn. The majority of the major contracts have successfully raised funds from financial markets on highly attractive long terms.

Empowering Ultraspeed

Pre-feasibility studies concluded that a Hybrid Bill provides the best legislative means of empowering the delivery of Ultraspeed. Recent precedent – both Channel Tunnel Rail Link and Crossrail – indicates that the Hybrid Bill procedure is the best available tool for progressing major infrastructure projects of strategic significance. The Hybrid Bill process also aligns well with the timescales and the best value competition and procurement imperatives of the PPP process. The legislative and the PPP processes should run in parallel so that, when both are completed with the parallel actions of Royal Assent and Financial Close, *power to deliver* the network is vested in an appropriate Project Delivery Entity, simultaneously with the PPP deal coming in to force to enable that Entity to *draw down the finance to build it*.

Empowering Britain's Economy & Enhancing Britain's Environment

One system, one technology, multiple benefits

We have seen how UK Ultraspeed can deliver *both* North:South and East:West strategic transport with *less* infrastructure and *faster* journey times than a hypothetical 'best case' high speed rail solution. This reflects the *minimum* objective of the project – to provide Britain with the world's most advanced ground transport network. But radical improvement in transport is only one of the principles on which the project is founded. UK Ultraspeed is designed not only to deliver a step-change in Britain's transport, but also to empower Britain's economy and enhance Britain's environment.

The system has been envisioned on a comprehensive, inter-city scale, but is designed to deliver economic benefits at many levels. Clearly 500km/h (311 mph) maximum speed has a dramatic effect on journey times *between regions*, but equally impressive acceleration and braking also slashes trip times between cities *in the same region*. The common factor is sheer speed, transforming access to and between key centres of the UK economy. In headline terms, Ultraspeed will deliver economic benefits on the following levels:

Metropolitan: significantly accelerating some journeys across or around major metropolitan areas.

Regional: effectively transforming pairs of cities into single economic entities, thus enabling them to compete as 'more than the sum of the parts' in the global economy. Also, in regions with two or more distinct economic poles, Ultraspeed connections will create cohesion on a regional scale.

Super-regional: overcoming the historic divisions between regions caused by distance. In the case of the 'Northern Way', Ultraspeed will effectively combine three regions – the North West, Yorkshire and the North East – into one globally competitive super-region capable of punching above its weight in the global competition for investment, jobs and wealth creation.

National: Ultraspeed will create a more sustainable balance between London and regional economies of the Midlands, the English North and Scotland, by transforming these areas as business locations, by making them as accessible as London itself.

International: Ultraspeed will make the superlative international connections of Britain's airports – including Heathrow – more easily accessible to and from the North than many locations within the M25 are today.

Ultraspeed benefits on a metropolitan and regional scale

This section uses the 'fit' between Ultraspeed and three key strategic issues at London/SE level (the Thames Gateway programme, the 2012 Olympics, and access to Heathrow) to illustrate a number of benefits. Many of the points discussed here using London/SE examples also apply in other parts of the country. The London focus here is merely one example, later sections look in detail at Northern and national issues. The one-off situation of 2012 highlights further strategic synergy – between Ultraspeed and the London Olympic and Legacy agendas – with the proposed terminal in Stratford serving the heart of London's Games. It should be stressed that the Ultraspeed business plan does not depend in any way on the 2012 Olympics, but there are certainly potentials worth exploring.

It is not proposed to construct an Ultraspeed route into the traditional centre of London. Rather, in the East, Ultraspeed supports the major regenerative push eastwards into the Thames Gateway, serving London via seven rail, tube and DLR connections from a terminal at London's best connected transport hub at Stratford. To the West, Ultraspeed both serves London *and* enhances national access to the UK's premier world gateway at Heathrow Airport.

Thus, even at the essentially local level of terminal location the *international* dimension is firmly in mind. Taking Stratford as an example, in addition to its superb local feeder/distributor links, a terminal at the Thames Gateway hub allows Ultraspeed to offer direct connections between the North and the Continent, via Channel Tunnel Rail Link. Such a connection would stream several million additional passengers a year through Stratford and would thus significantly enhance the revenue performance of the CTRL PFI. There would be a similar, mutually beneficial, relationship between Ultraspeed and the proposed Crossrail route from Stratford, through Central London, to Heathrow.

As the following table illustrates, Ultraspeed can provide a very rapid shuttle service from Stratford at the foot of the Lee Valley to a strategic Park & Ride location at the M25/M1 junction. Whilst this route section primarily serves the intercity and inter-regional requirements of Ultraspeed, it would also facilitate access to the Olympic Park from areas to the North of London. As such it aligns perfectly with the Olympic transport strategy.

Origin	Intermediate Calling Points	Destination	Approx. Journey Time
London Thames Gateway: Stratford (Olympic Hub)	–	M25/M1 Park & Ride	10 mins
Heathrow Airport	–	M25/M1 Park & Ride	6 mins
Heathrow	M25/M1 Park & Ride	London Thames Gateway	20 mins
London Thames Gateway: Stratford (Olympic Hub)	M25/M1 Park & Ride	Birmingham International Rail and Air Hub M6/M42 NEC	30 mins

Ultraspeed is also uniquely placed amongst new high speed ground transport initiatives to meet the unmovable deadline of the Olympics. It is a proven matter of historical fact that a short point-to-point Transrapid system designed for intensive shuttle traffic can be built in less than three years. The 30 km Shanghai route was designed and built in less than two years from signature of contract in Spring 2000 to its maiden trip on 31 December 2002. After a period of trial running, the system opened to the public precisely one year later: in all, under three years from contract to public operation. Obviously this was achieved under Chinese planning law, not British. However, the Olympic deadline will itself imbue domestic planning with both urgency and pragmatism. Transrapid systems are *proven* to be deliverable to the tightest of schedules: London need be no exception.

Even looking at a narrowly-defined short-route, high-capacity, shuttle, there is a compelling case for Ultraspeed, as tabulated here.

Key factors of a potential shuttle between the 2012 Olympic site and the M25/M1 junction		Observations
Route length	39.5 km	The rapid acceleration and braking abilities of Transrapid, coupled to high point-to-point speed allow Ultraspeed to provide an intensive 'shuttle' service between the Olympic site and the key road junction to the North of London. For other modes of transport, this is already bordering on an 'outer suburban' route length.
Vehicle capacity	1,200 max	With interior layouts configured for maximum density, a single Ultraspeed can seat as many people as 24 road coaches with 50 seats each.
Frequency (max)	every 10 minutes	With up to 6 Ultraspeed departures each way every hour, 288 road coaches (and their drivers) would be needed simply to provide the same number of seats each hour at both terminal points.
Journey time	10 minutes	Ultraspeed journeys will be up to 10 times quicker than road transport in congested urban locations. This actual journey often exceeds 100 minutes by road at peak times. In real world terms this means that just three to five Ultraspeed units – configured to provide a fast, frequent and very high capacity shuttle – can deliver the same practical journey capacity between the same origin and destination points as several hundred road coaches or several thousand private cars.
Daily total capacity (both directions combined)	180, 000 pax 259, 000 pax	in Ultraspeed intercity configuration of 840 seat units, 18 hour operation. in 'shuttle' configuration with 1,200 seats, 18 hour operation.
Comparator: Ultraspeed (1200 seat)	47,400 ASK	In 10 minutes 1,200 Ultraspeed seats will cover 39.5km, making a total of 1,200 x 39.5 = 47,400 Available Seat Kilometers [ASK] per single trip.
Road coach (50 seats)	400 ASK	In 10 minutes the 50 seats on a road shuttle coach would cover a maximum of 8km, assuming – optimistically – that it is able to travel at the urban speed limit (30mph / 48km/h) for the entire time. [50 x 8 = 400 ASK]
Car (5 seats)	40 ASK	Subject to the same urban speed limits, a 5-seater car produces only one tenth the usable transport benefit (measured in ASK) as the coach and less than one hundredth of Ultraspeed [5 x 8 = 40 ASK]

This examination of how Ultraspeed could serve the specific transport needs of the 2012 Olympics reveals many of the generic benefits of speed, frequency and capacity that would apply in *any* application on a city-to-regional scale. The principles illustrated here over a 39.5km 'Olympic Shuttle' route would also apply in even fuller measure over short route sections between city pairs.

- The roughly 50km route between Liverpool and Manchester also has a 10 minute journey time – due to a straighter, faster alignment.
- The Glasgow to Edinburgh and Teesside to Tyneside routes both offer point-to-point journey times under 15 minutes, although they total 75 km and 55 km respectively.

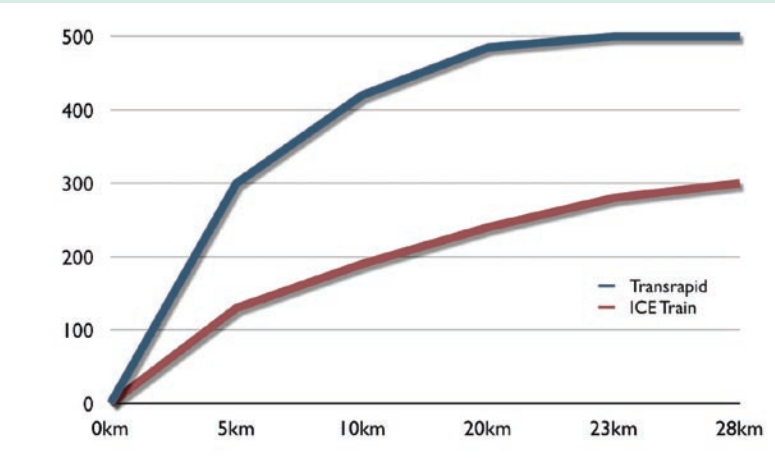
The potential 'Olympic Shuttle' route provides a typical illustration of the benefits of frequency and capacity that Ultraspeed can deliver on a metropolitan scale. But the sheer speed of Ultraspeed means that more benefit is delivered by planning on a larger, regional scale.

- The Stratford to M25/M1 Parkway section can be extended to Heathrow. This will provide a sub-30 minute link between the world's best connected airport and Europe's most significant economic development zone in the Thames Gate-way. This will be a major benefit for both for the Games period and, of course, for decades afterwards.
- With only an additional 17 minute journey time from an M1/M25 P&R terminal, Ultraspeed will reach the major transport hub of Birmingham International Airport and Rail Station, the M6/M42 junction and the NEC with its high capacity car parks. Not only would this serve the 2012 agenda by unmistakably linking London's Olympics with the country beyond the capital, it would also put in place a world-beating public transport backbone between the First and Second cities whose benefits would endure to 2112 and beyond.

Benefits at regional, super-regional and national levels

Flexible technology delivers benefits over a wide geographic range

Ultraspeed offers the fastest journeys possible by any mode of transport both between conurbations separated by hundreds of kilometres and on shorter routes between city pairs only 50 km or so apart. This derives from Transrapid's combination of 500 km/h maximum speed with an ability to accelerate and brake much faster, and over a much shorter distance, than even the best contemporary high speed trains, such as the German ICE.



As the acceleration curves illustrate, Transrapid reaches 300 km/h in only 5 km, whereas the ICE requires 28km to reach the same speed. By this distance, of course, the Transrapid vehicle is travelling at 500 km/h – and has been for the last 5.3 km, maximum speed being reached at 22.7 km.

The time taken to accelerate is also important. Transrapid will reach 300 km/h in only 2 minutes and 9 seconds. High speed trains will take at least four times longer to reach the same speed.

Still from video taken on board the 14:40 Transrapid departure from Shanghai.

The speedometer shows 300km/h attained at precisely 14:42:09.

The standing passengers are testimony to the smoothness of both ride and acceleration.

Shanghai's Transrapid goes on to achieve its cruising speed of 430 km/h at 3m 14sec after departure.

It is this performance over relatively short distances that enables UK Ultraspeed to bind city-pairs such as Liverpool and Manchester, Teesside and Tyneside, or Glasgow and Edinburgh into *single* super-cities, effectively combining the strengths of both halves to compete more powerfully in the global economy.

A compelling precedent exists from Scandinavia, where a strategic infrastructure intervention – the new fixed link between Copenhagen and Malmö – has combined major cities *in two countries* into a new European metropolis of 3.6 million population. Independent studies have identified a very significant increase in inward investment into the area. Similar or greater benefits would be expected by linking any two major UK economic centres, ideally with an internationally-served airport also connected directly to the route (as Copenhagen airport serves the new super-region of Trans–Øresundia).

"Infrastructure investment creating a new and competitive metropolis.It is worth noting that since the opening of the Øresund Bridge, there has been a noticeable positive upturn in inward investment in the region [and] unemployment has recently started to decline [...]

The bridge is the result of successful public-private partnership that has already had a measurable impact on mobility, labour and housing markets in the wider Øresund region, fostering the development of a "bi-national, integrated and functional metropolis with strong backing from its citizens"

Prof R Burdett: Proof of Evidence re Thames Gateway Bridge, May 2005

Last year [2004] the Øresund Region attracted 76 inward investment projects. This corresponds to a Scandinavian market share of 38%, and positions the region as the third biggest receiver of investment projects in Europe - only superseded by London and Paris […]

The increase in investment projects in Skåne (the Swedish province linked to Denmark by the bridge) and Skåne's continually rising share of inward investment projects in Sweden, can, in part, be ascribed to the ongoing integration of the Øresund Region and Greater Copenhagen's strong position in the European market.

Copenhagen Capacity, Sept 2005, citing Ernst & Young 'European Investment Monitor'

Building super-regions

At the super-regional level, Ultraspeed will deliver most powerfully on the 'Northern Way' agenda. Here the point of departure is that England's 'Greater North' (the North West, Yorkshire & Humber and the North East) is £29bn less productive than the UK national average, *every year*. Combining inputs from the Regional Development Agencies and from across Central Government, Northern Way policy clearly identifies strategic transport as a top priority:

> Regions prosper when they are well connected; world-class transport links are essential elements of competitive advantage. Manchester Airport is the North's only major international gateway; congestion on the road and rail routes serving the airport will start to limit its ability to serve the North's businesses. Thus [...] we must improve surface access [...] to Manchester Airport along with preparing a Northern Airports Priorities Plan to identify how to secure the growth of all the North's airports.
>
> [W]e must also invest in creating better integrated public transport services within and between our city regions; these are key to efficient labour markets and to enable those living in the deprived communities to access jobs elsewhere. [...] We see a need to invest in better...links between the city regions centred on Manchester and Leeds in particular and to boost the capacity of the M62 corridor.
>
> Northern Way Growth Strategy: 2004

The UK public sector has mapped the Northern Way and has set out the policy aspirations. Ultraspeed provides the most comprehensive means to translate them into a built, financed and operational reality. With the East:West route section offering a 60 minute link across the *whole* North (Merseyside – Manchester – Yorkshire – Teesside – Tyneside) Ultraspeed delivers the Northern Way, the Truth and the Light. The *whole* of this 'Greater North' (£161bn GDP and 15 million people, according to 2003 RDA figures) would be connected to Manchester Airport with a maximum of 45 minutes journey, delivering in reality Manchester Airport's stated aspiration "to make our public transport links the best of any airport in the world." (Manchester Airport Ground Transport Strategy, 2004).

Expanding the Northern Way to include the Scottish Central Belt further reinforces the super-regional economics. Adding the metropolitan centres of Edinburgh and Glasgow (and one or both of their major airports) creates a 'Golden Banana' with the global economic 'clout' to rival the now over-ripened fruit of the Bristol – Stuttgart – Barcelona parabola. The numbers are conclusive. Preliminary independent macro-economic study by CURDS, University of Newcastle, analysed the potential impact of Ultraspeed over a Glasgow – Edinburgh – Tyneside – Teesside – West Yorkshire – Manchester – Merseyside route. They measured the effect of an ultra-high-speed connection between these centres, by comparing the overall economic power of these city-regions to that of today's Greater London, both before and after the construction of such a link.

	macro-economic power expressed as a percentage of the Greater London region's current status	
City Region (examples)	current position	with Ultraspeed
Greater Manchester	32.1%	78.5%
West Yorkshire	17.0%	33.9%
Tyneside	15.3%	33.6%
Glasgow	18.1%	47.1%

CURDS: University of Newcastle; report for One North East, 2004

As the CURDS team themselves conclude, the positive effect of Ultraspeed in currently peripheral economies is to "reduce the friction of distance to around one third of its current levels [...and...] for the first time in over a century, [...to] create the very real possibility of a major realignment in the UK's economic geography" [ibid]

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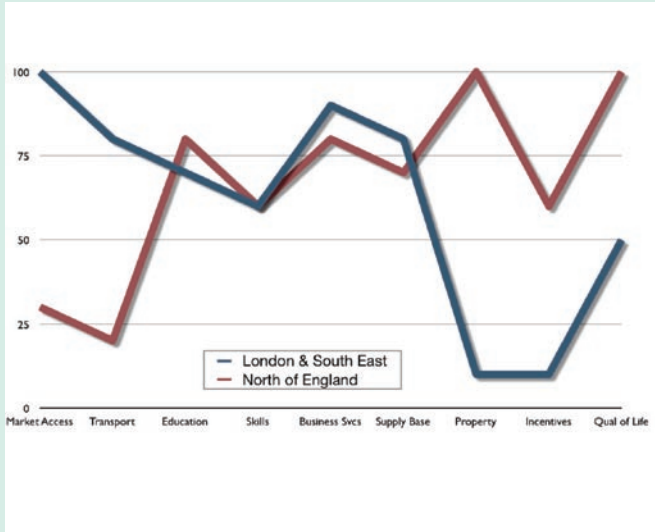
Rebalancing Britain

In short, UK Ultraspeed has the potential to rebalance Britain, to engender a more sustainable relationship between Britain's world city – London – and the regional economies of Scotland and the English north, by helping create world-class locations, with world-beating access, outside the capital. Nationally, Ultraspeed is thus designed to act as an anchor and a catalyst for the broader economic development thrust to 're-profile' peripheral economies, to make them more accessible to the global economy and, thereby empower them to attract and retain investment in the face of ever fiercer global competition.

Represented graphically, a potential inward investor's comparative analysis of the attractions of London and South East against the North of England as a business location is likely, today, to produce the profile on the left. Ultraspeed 'reprofiles' regional balance to the status shown on the right.



Comparison of UK economies against global location criteria for inward investment **without** Ultraspeed

Performance of best location worldwide against a criterion from investor perspective = 100

Performance of worst location worldwide against a criterion from investor perspective = 0

Status 2005

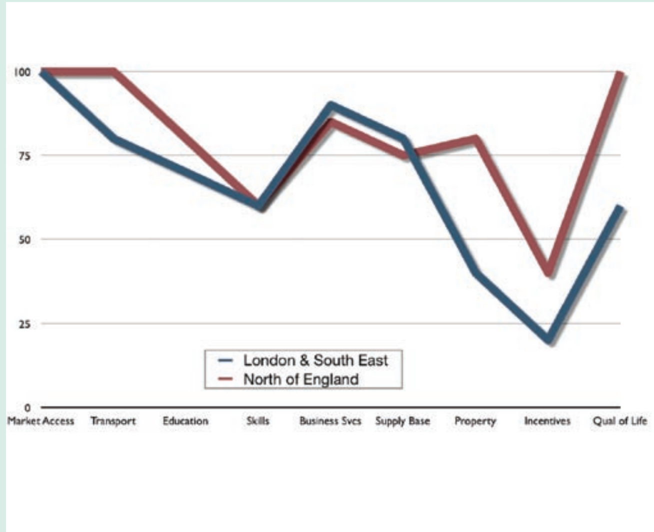
Good global links to London, but poor North – South transport hampering access to North.

North as ex-industrial zone offers readily available property and reasonable inward investment incentives.

Higher quality of life in North, London quality of life compromised by overheating and overcrowding.

London offers no significant inward investment incentives – it doesn't need to.

North out-scores London on many aspects, but market access and transport are always the decisive factors.



Comparison of UK economies against global location criteria for inward investment **with** Ultraspeed

Performance of best location worldwide against a criterion from investor perspective = 100

Performance of worst location worldwide against a criterion from investor perspective = 0

Status after Ultraspeed is embedded as a foundation of Northern economic competitiveness:

Good global links to London continue.

Ultraspeed transforms North – South transport to best-in-world levels.

Trans-North link creates 'Greater North' super-region leading to increase in competitiveness.

Super-regional connection empowers the growth of a world air gateway in the North and for the North.

Greater North can thus reduce incentives as the region becomes more attractive.

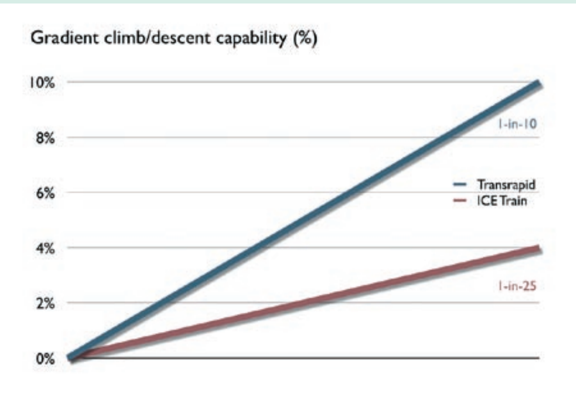
De-stressing London/SE improves Quality of Life in that region

> At the 'Greater North' level, the Ultraspeed mission is to change the variables; to make the brownfields of Teesside, for instance, as accessible to Heathrow in time terms as Canary Wharf on today's public transport (around 85 minutes). Similar 'reprofiling' benefits will also apply in Scotland, with Ultraspeed 'leveling up' regional economies to the standards of the best.

Economic and environmental benefits in balance

Empowering economic growth and thus engendering a more sustainable balance between North and South is, in itself, a major environmental gain at a strategic level. A connected, competitive North takes pressure off the stretched housing, land and water resources of the South, whilst bringing Northern surpluses of these national strategic assets into long term play. But Ultraspeed also performs at an immediate, short term, level – the fundamentals of the Transrapid technology make significant contributions to reducing the environmental costs of transport whilst simultaneously delivering increased economic benefits of speed, connectivity and capacity.

Flexible route parameters minimise environmental intrusion



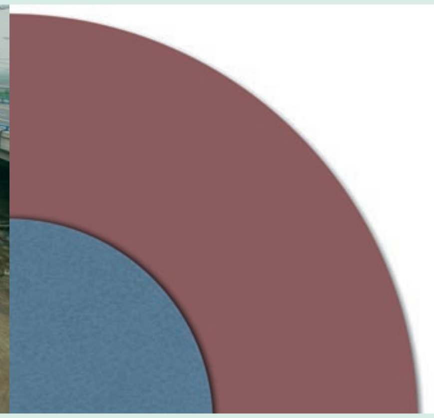
Transrapid can ascend & descend gradients of 1-in-10 (10%).

Typical high speed rail alignments have a maximum gradient of only 1-in-25 (4%).

These flexible routing parameters allow Ultraspeed to 'fit' UK landscape with few major civil engineering works.

Construction in Shanghai illustrates how a very high speed Transrapid alignment can be built actually inside the central divide of a major highway.

With a cant of maximum 12°, flexible alignments alongside or above existing transport corridors are possible, thus reducing new environmental intrusion.



Turn radii at 300 km/h

Transrapid 1.6 km

TGV 3.2 km

Matching the flexibility in vertical layout, lateral alignment is also extremely advantageous compared to high speed rail routes, allowing for much tighter curvature at comparable speeds.

most advanced, most reliable and most sustainable intercity transport system in the world

The M62 over the Pennines is a typical location where colocation alongside a motorway could be beneficial. The environmental incision was made when the motorway was built, Ultraspeed would simply make additional and more sustainable use of the *existing* transport corridor.

In Transrapid, 300 km/h is typically attained after 5 km, in the urban fringes. At this speed the guideway can curve sharply in precisely half the turn radius of a high speed rail line. This enables the route to thread in and out of terminals with much greater flexibility than a rail line. It is also much more economical in land take. Such flexible routing enables Ultraspeed to follow brownfield alignments where available, thus minimising new environmental and visual intrusion in heavily populated areas.

Environmental benefits in design and operation

Transrapid systems also reduce the environmental burden of travel through efficient design and operation. To cite a few key examples: regenerative braking returns power to the grid when vehicles decelerate; precise control and distribution through the linear motor ensures no excess propulsive power is supplied to zones where it is not needed. Further benefits are tabulated below.

Factor	Ultraspeed	Comparator
Noise dB(A) at 25m from route at typical speeds in urban/rural areas	73 @ 200km/h 88.5 @ 400km/h	TGV: 85 @ 200km/h Suburban train: 80 @ 80km/h TGV: 92 @ 300km/h
Energy consumption: watt-hours per seat km at 300km/h	34	ICE: 51
CO_2 emissions in grams per seat-km *Using German electricity generation mix input data. Carbon-free generation would enable absolute zero emissions.*	23 @ 300km/h 33 @ 400km/h	ICE: 30 @ 300km/h Car: 60 Shorthaul flight 190
Electromagnetic field in vehicle (μTesla) *effects along/under guideway are even weaker*	100	colour TV: 500 hairdryer or electric stove: 1000

Source: TRI summary of independent tests by German Federal agencies

By connecting more places, in fewer and faster vehicles, with more seats per vehicle, operating along a single route, the overall power requirement to provide a given number of Available Seat Kilometres in a given period of time is exceptional. Whilst detailed analysis will not be possible until the next stage of study, preliminary results show Ultraspeed consuming approximately half the overall power of a slower high speed rail service from London to Northern destinations. Road or short haul air simply cannot enter this equation – London to Manchester by car in an hour is manifestly technically impossible; providing a similar quantum and frequency of service by air would massively exceed airport and air traffic control capacity.

Finally, Ultraspeed delivers economic advantage at the international level whilst simultaneously reducing a pressing environmental burden of national importance. By offering journeys that are quicker, more frequent and more comfortable than domestic air travel, Ultraspeed has the potential to replace much short haul air travel in the UK. Firstly this reduces atmospheric pollution, with as little as 20% of the emissions being achievable, depending on aircraft type, route length and electricity generation mix. Secondly, and equally importantly, this also frees up thousands of runway slot pairs each week, most notably at the notoriously congested Heathrow. A third tier of benefit then results by liberated airport capacity becoming available for use by medium and long haul traffic, which is both environmentally more efficient and economically more beneficial, as it enhances Britain's *international* connections.

Environment and economy in balance – and a step change in Britain's transport

In conclusion, UK Ultraspeed offers a unique package of environmental benefits, whilst simultaneously creating very significant economic benefits for Britain. The ultimate goal of the UK Ultraspeed project is to deliver all of these economic and environmental gains, whilst cementing Britain's competitive advantage in the global economy with the most advanced, most reliable and most sustainable intercity transport system in the world.