Developing High Speed Rail for Britain

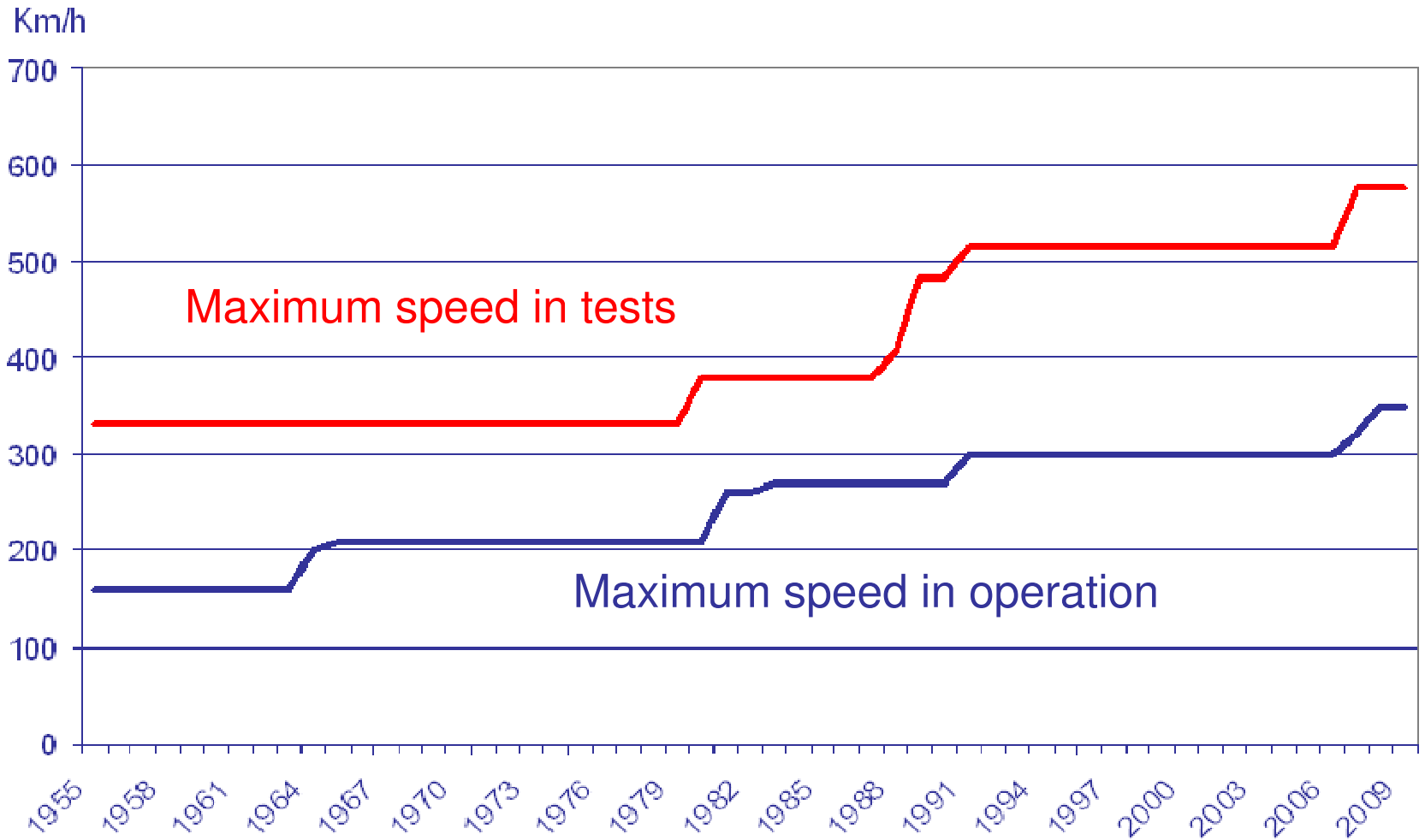
Prof Andrew McNaughton

19th March 2012

High Speed Rail Is 47 Years Old

1964 in Britain…

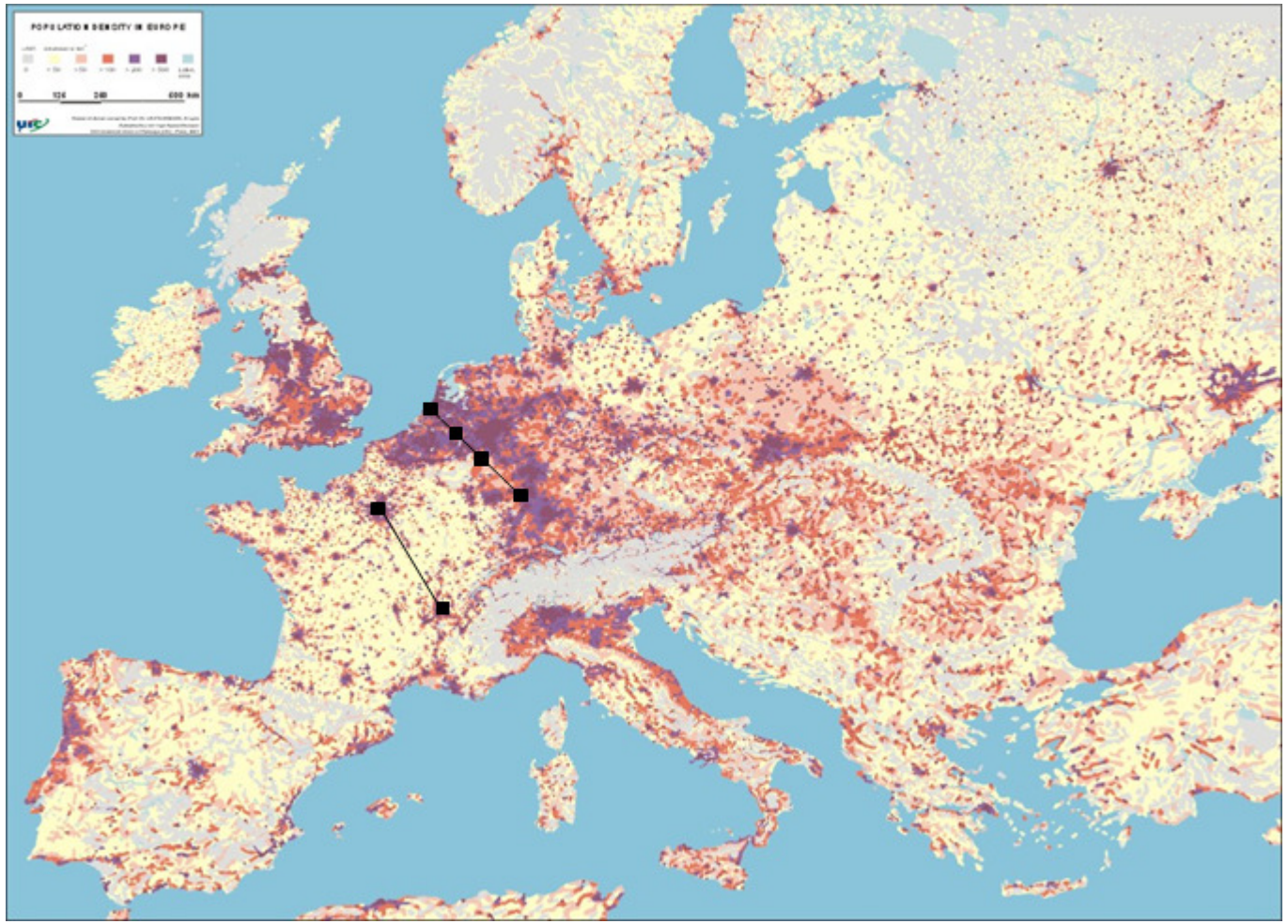
It continues to evolve technically



Japan Now

Gallic Flair…574.8kph

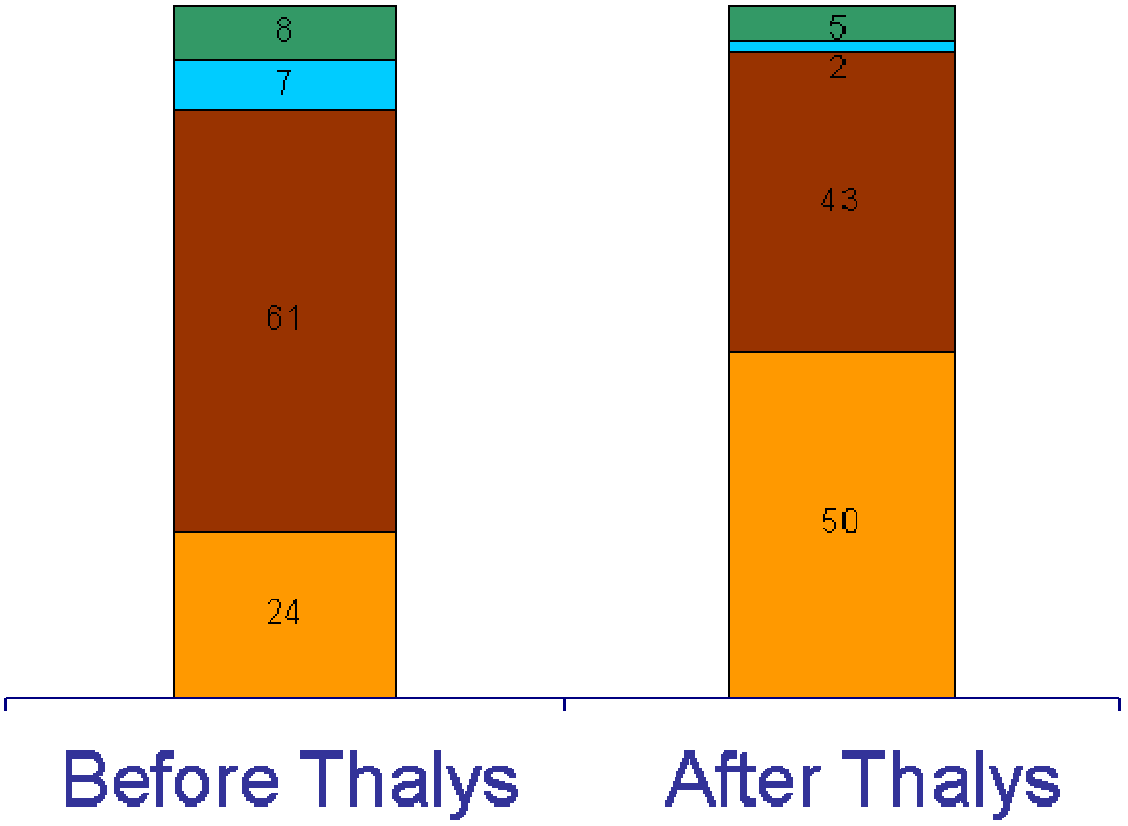
Population Density



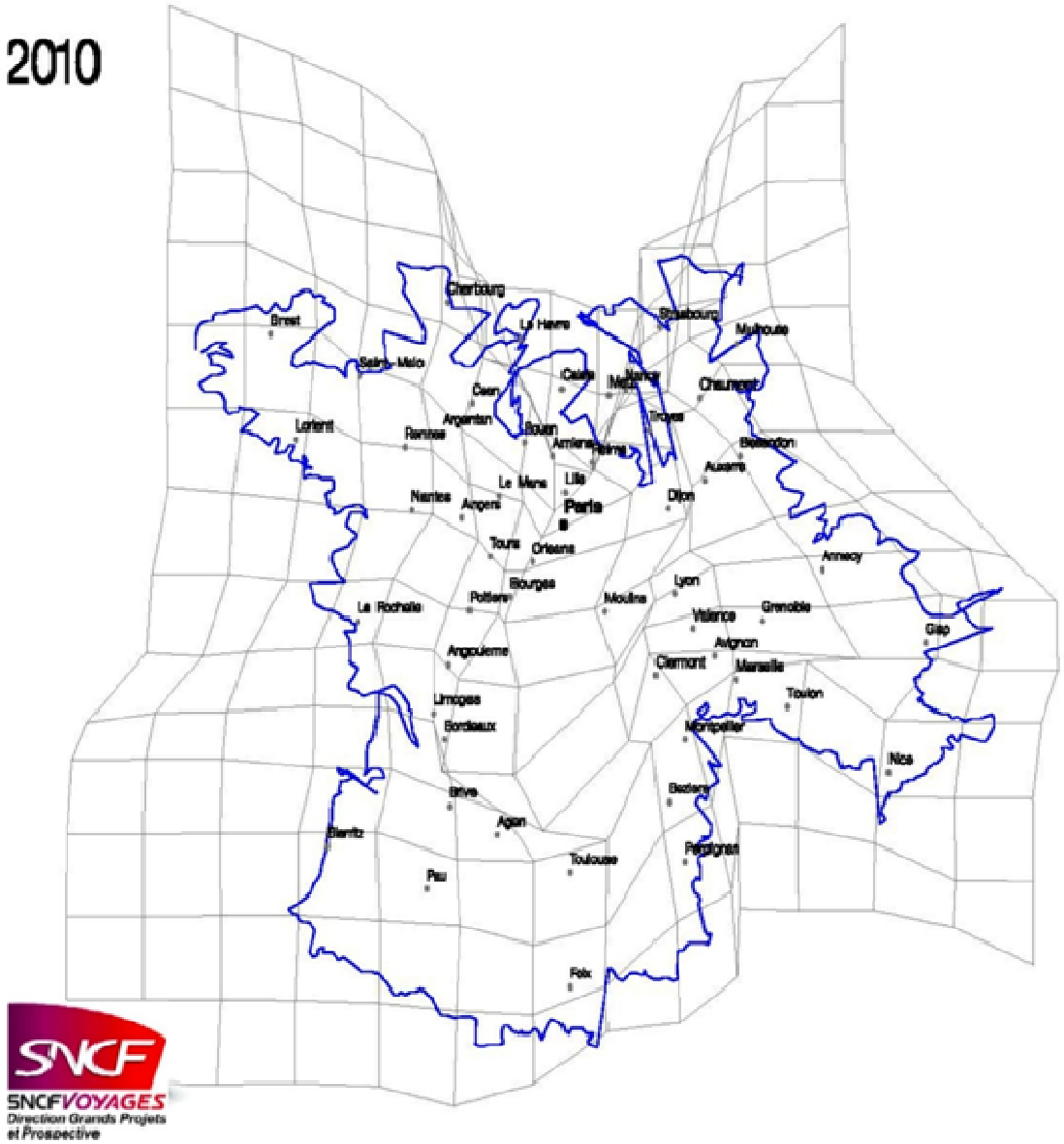
Thalys (Paris-Brussels)

Modal Change

Paris - Brussels (2hr 25min to 1h25min)

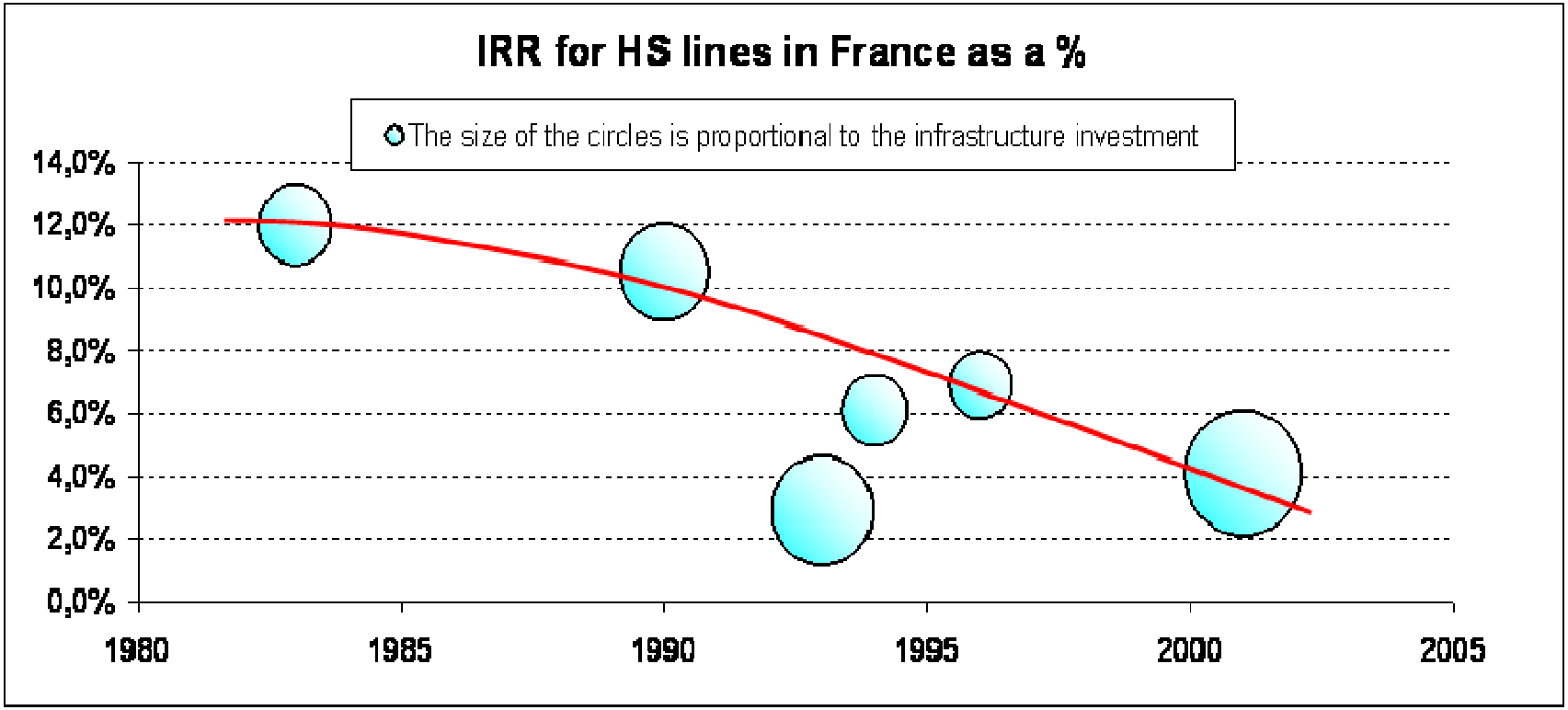


The French Experience

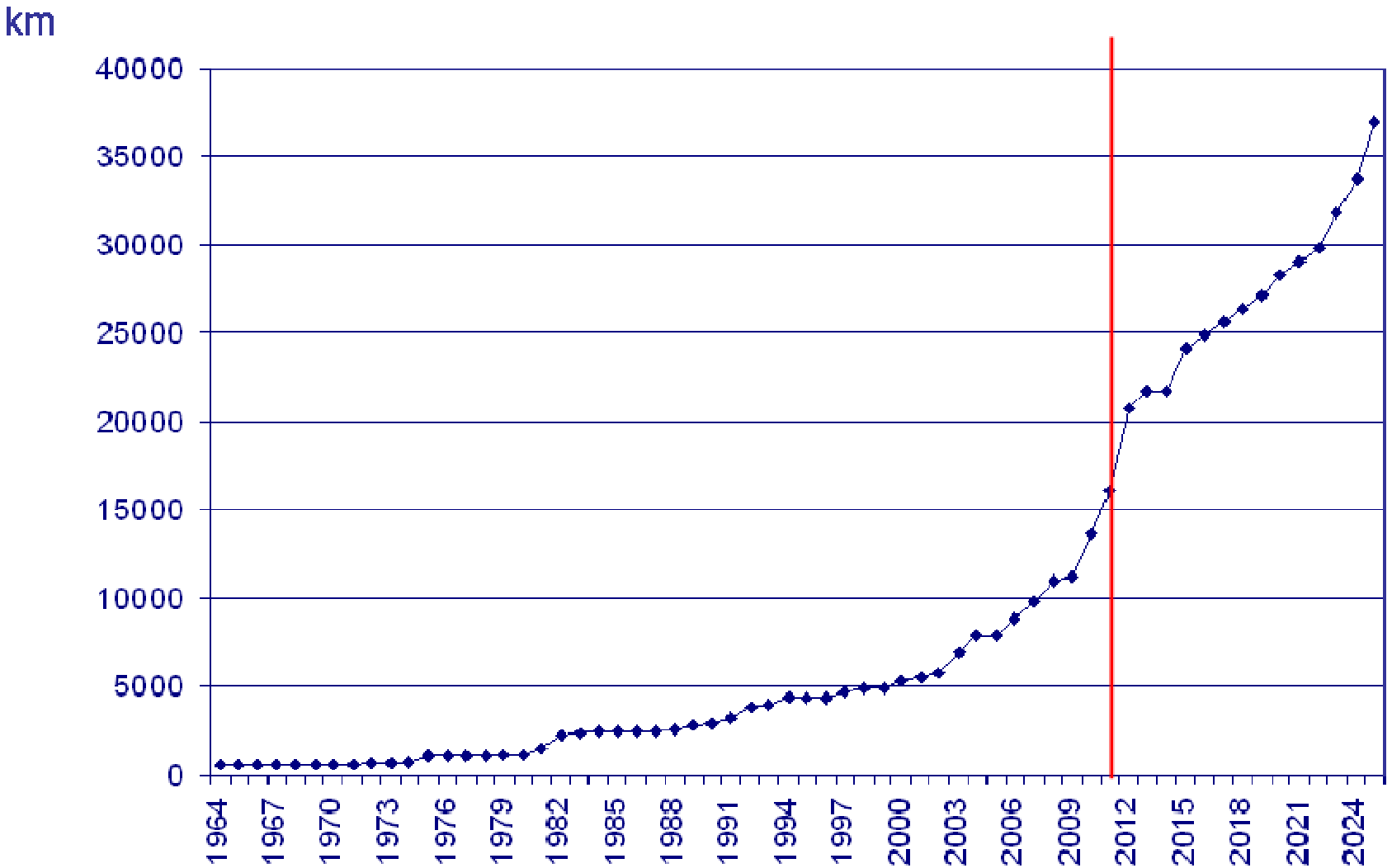


The French Financial Lesson

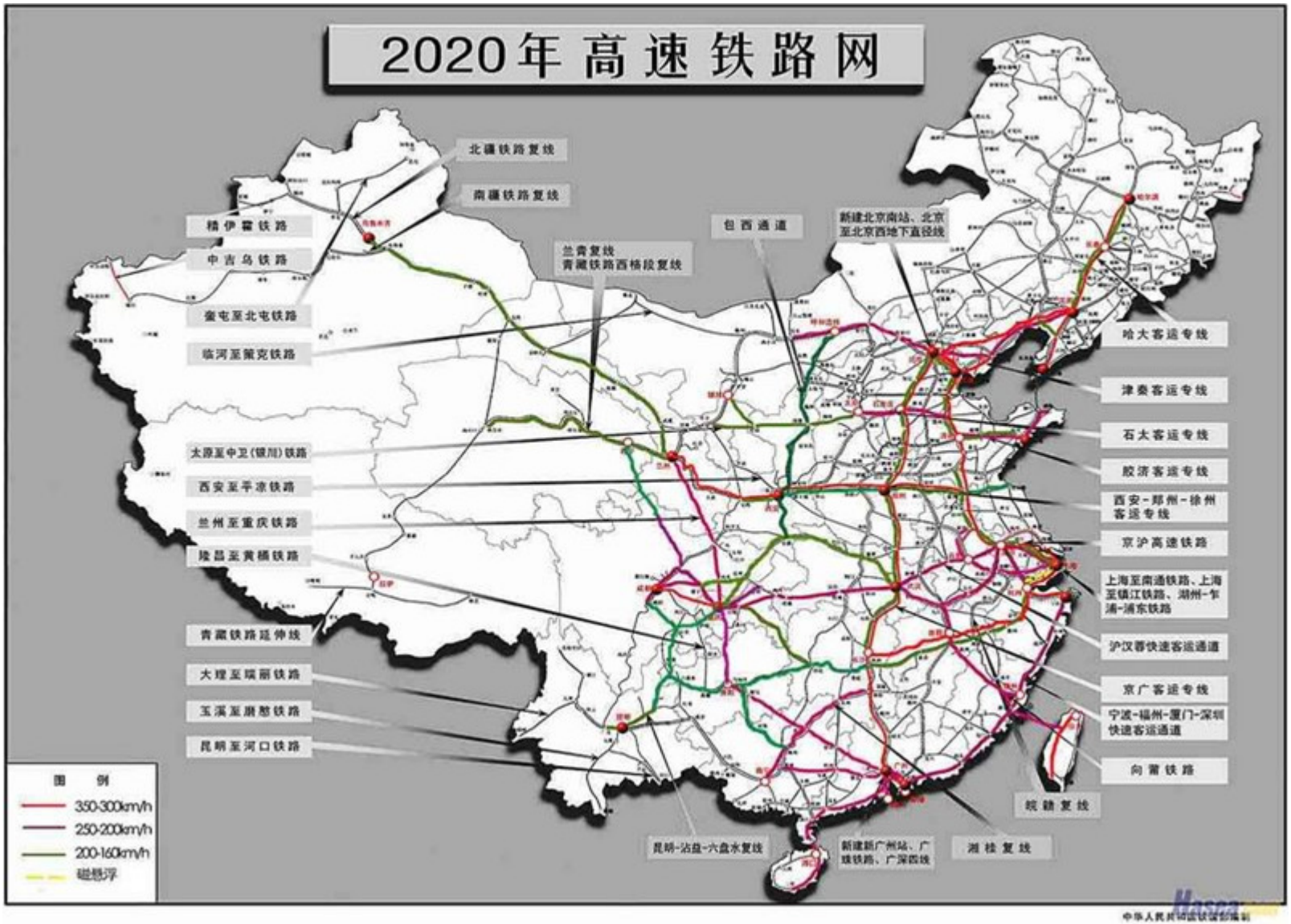
- HSR on the trunk routes has had a good rate of return.
- Branches and twigs have been justified on “strategic” arguments



Planned World HSR Development

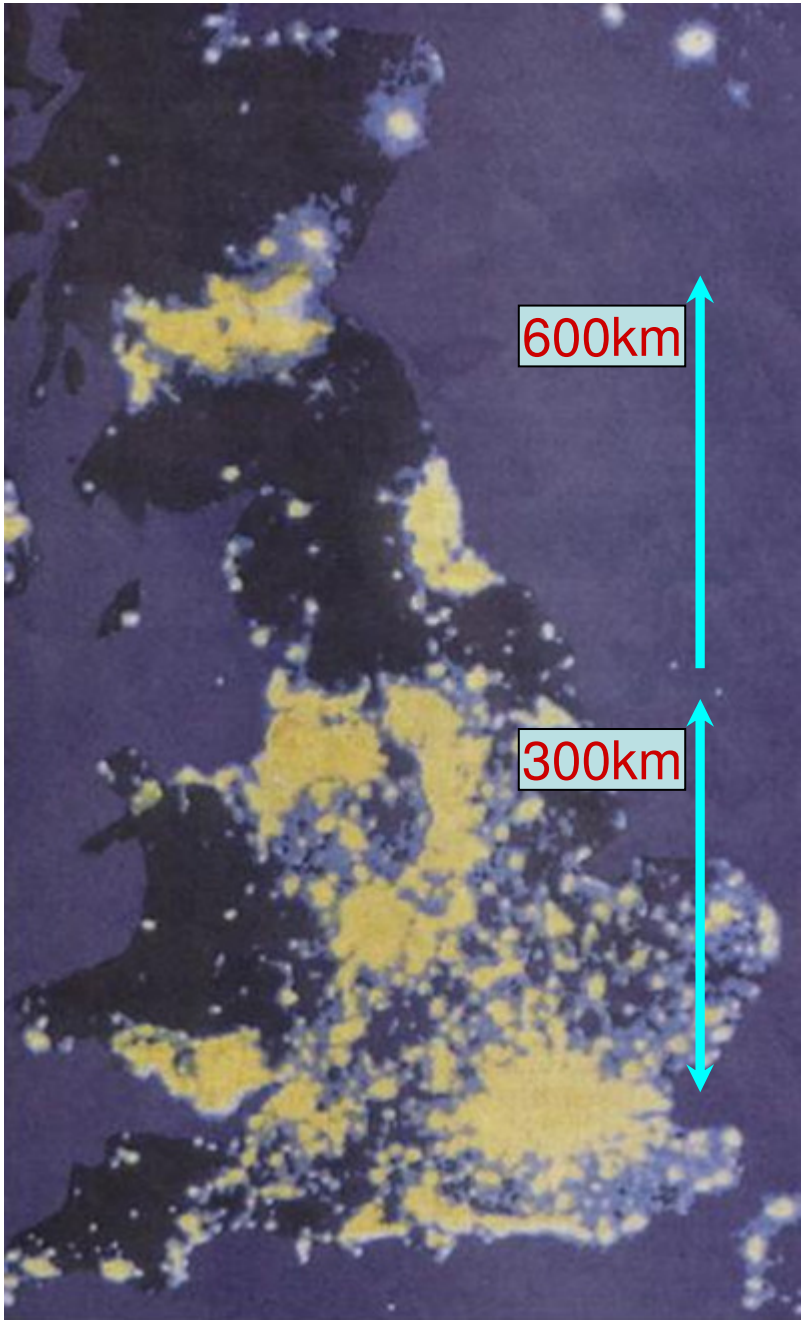


China - 2020


2020年高速铁路网
北疆铁路复线
南疆铁路复线
精伊霍铁路
中吉乌铁路
奎屯至北屯铁路
临河至策克铁路
太原至中卫(银川)铁路
西安至平凉铁路
兰州至重庆铁路
陇昌至黄桶铁路
青藏铁路延伸线
大理至瑞丽铁路
玉溪至磨憨铁路
昆明至河口铁路
兰青复线
青藏铁路西格段复线
包西通道
新建北京南站、北京至北京西地下直径线
哈大客运专线
津秦客运专线
石太客运专线
胶济客运专线
西安-郑州-徐州客运专线
京沪高速铁路
上海至南通铁路、上海至镇江铁路、湖州-乍浦-浦东铁路
沪汉蓉快速客运通道
京广客运专线
宁波-福州-厦门-深圳快速客运通道
向莆铁路
皖赣复线
湘桂复线
新建新广州站、广珠铁路、广深四线
昆明-沾益-六盘水复线
图 例
350-300km/h
250-200km/h
200-160km/h
磁悬浮

Japan

In operation
Under construction
In project



A Small Country

London to:

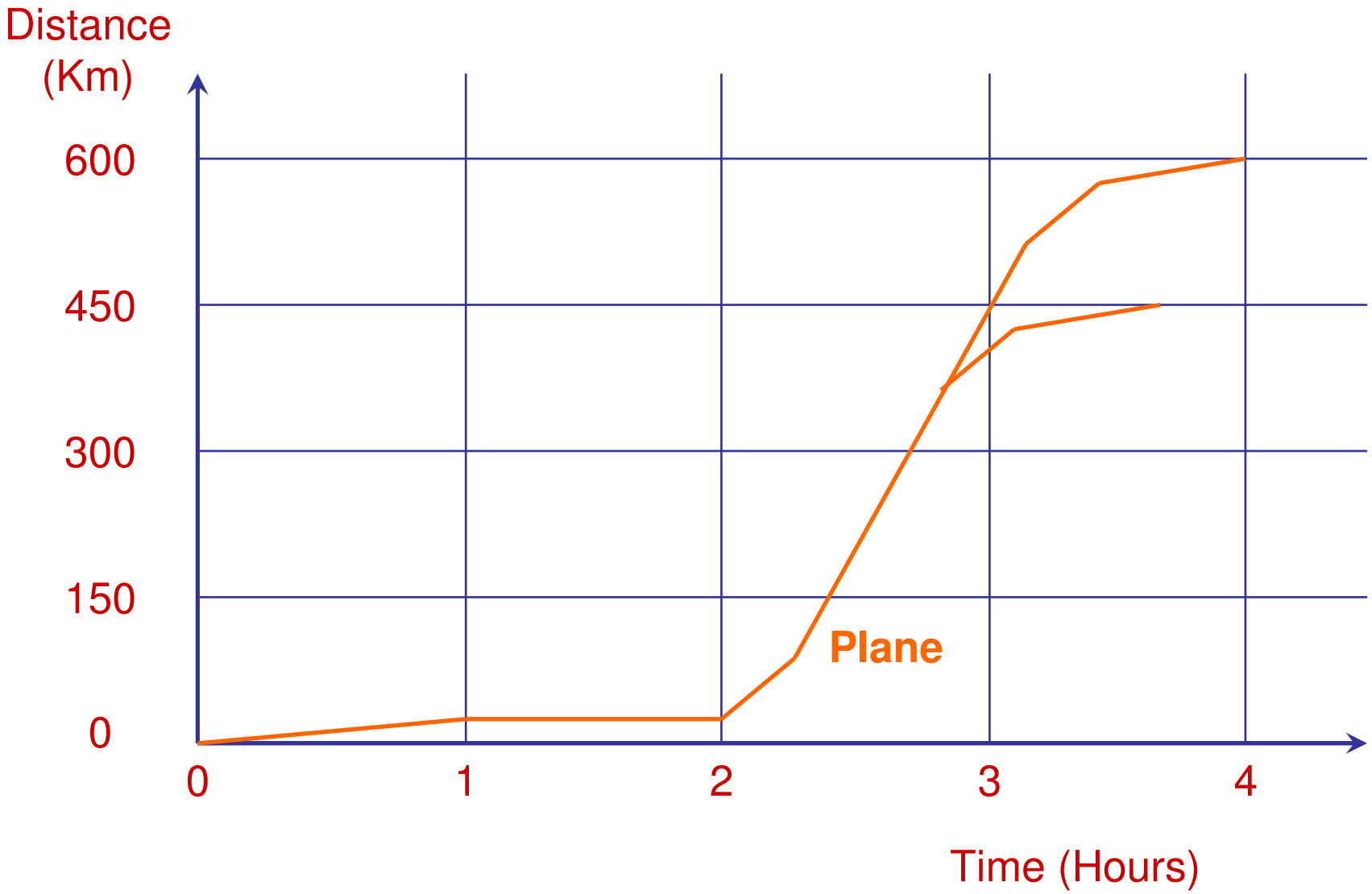
- The North East
  - Paris – Lyon
- Manchester / Leeds
  - Paris – Brussels
- West Midlands
  - Frankfurt - Cologne

Britain is Growing

England's Population

- 2008 52m
- 2033 60m
- 2050 70m

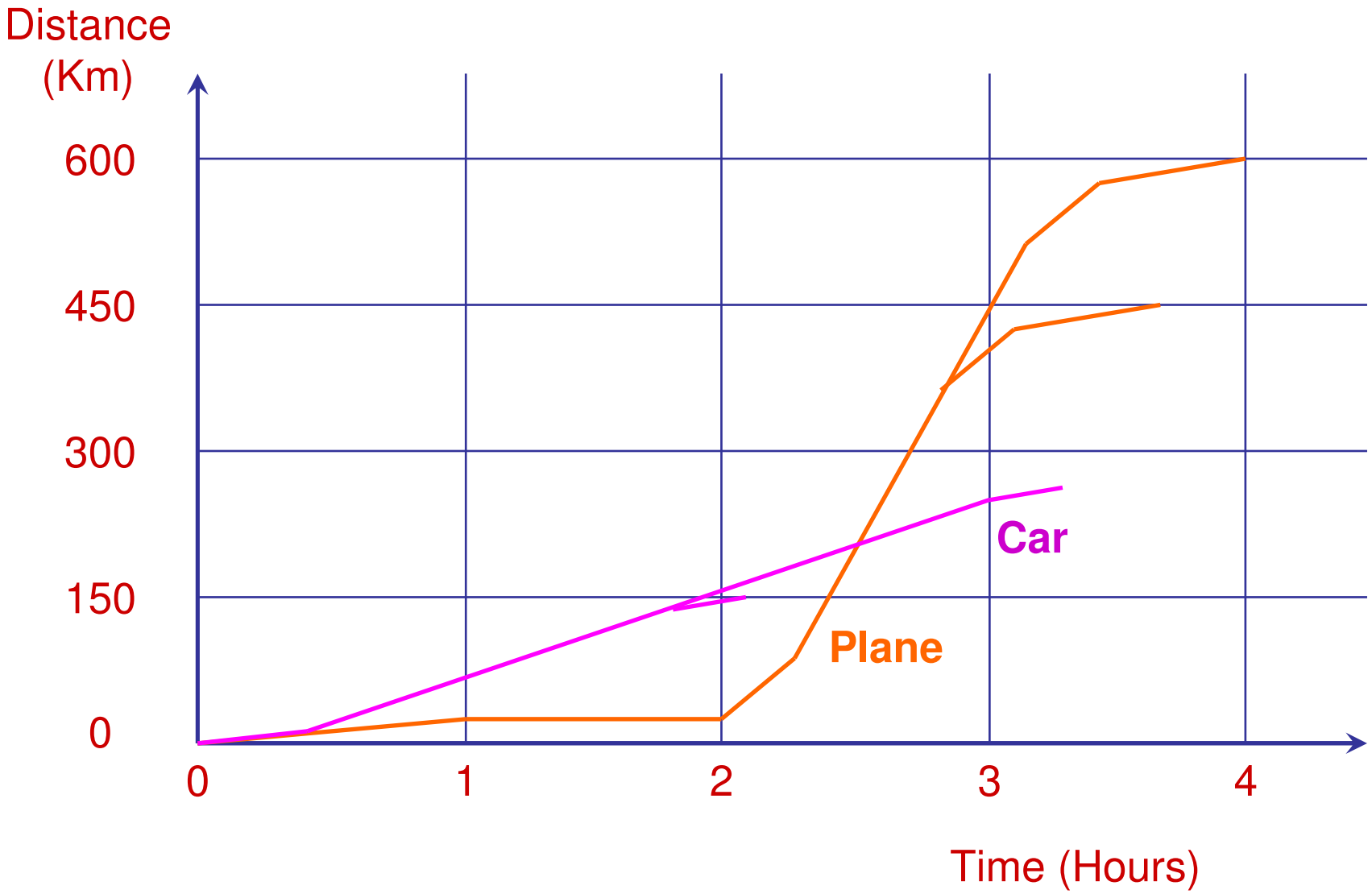
Door To Door Journey Time



High Speed Low Capacity

The Inter City Express

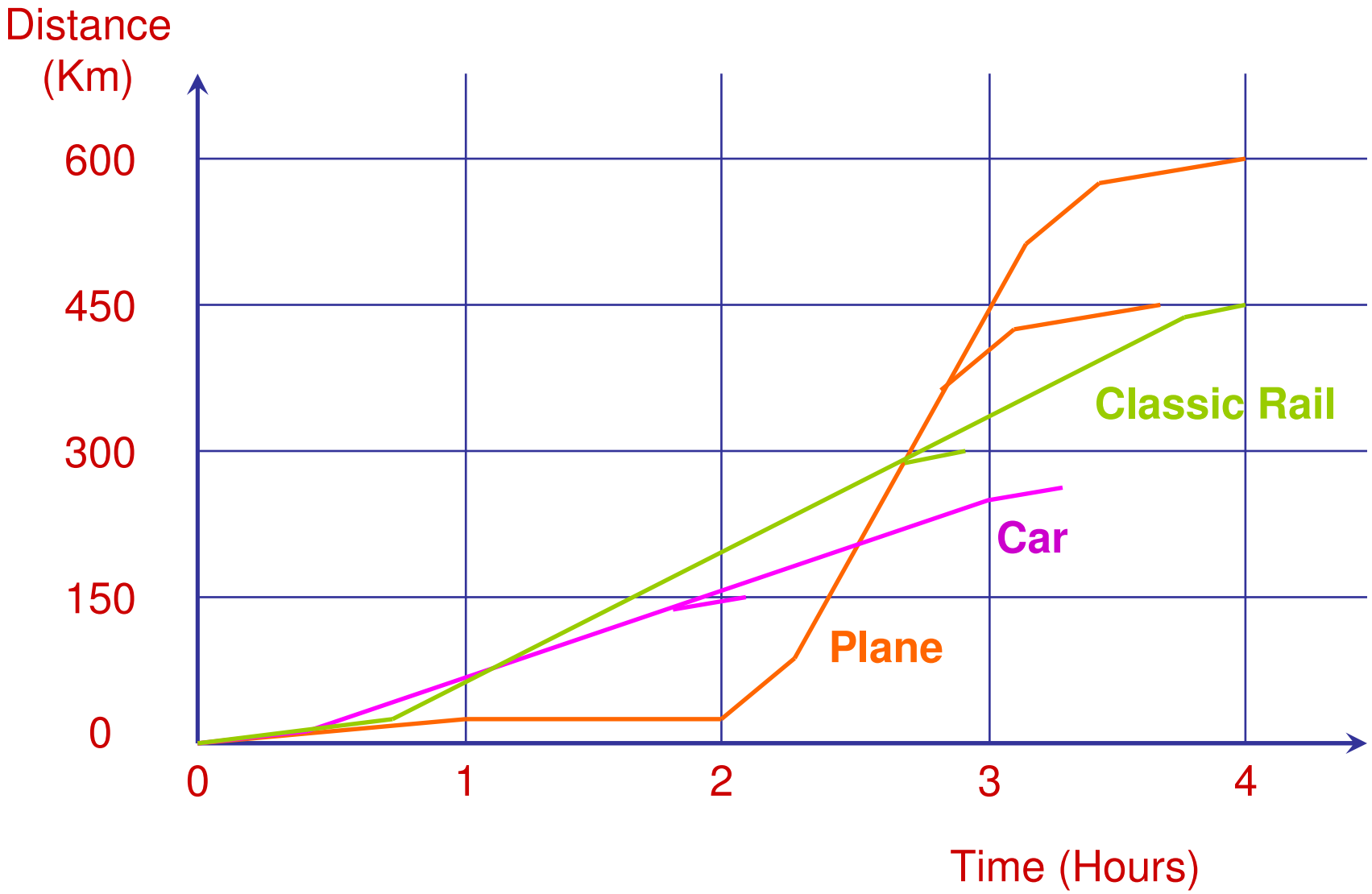
Door to Door Journey Time



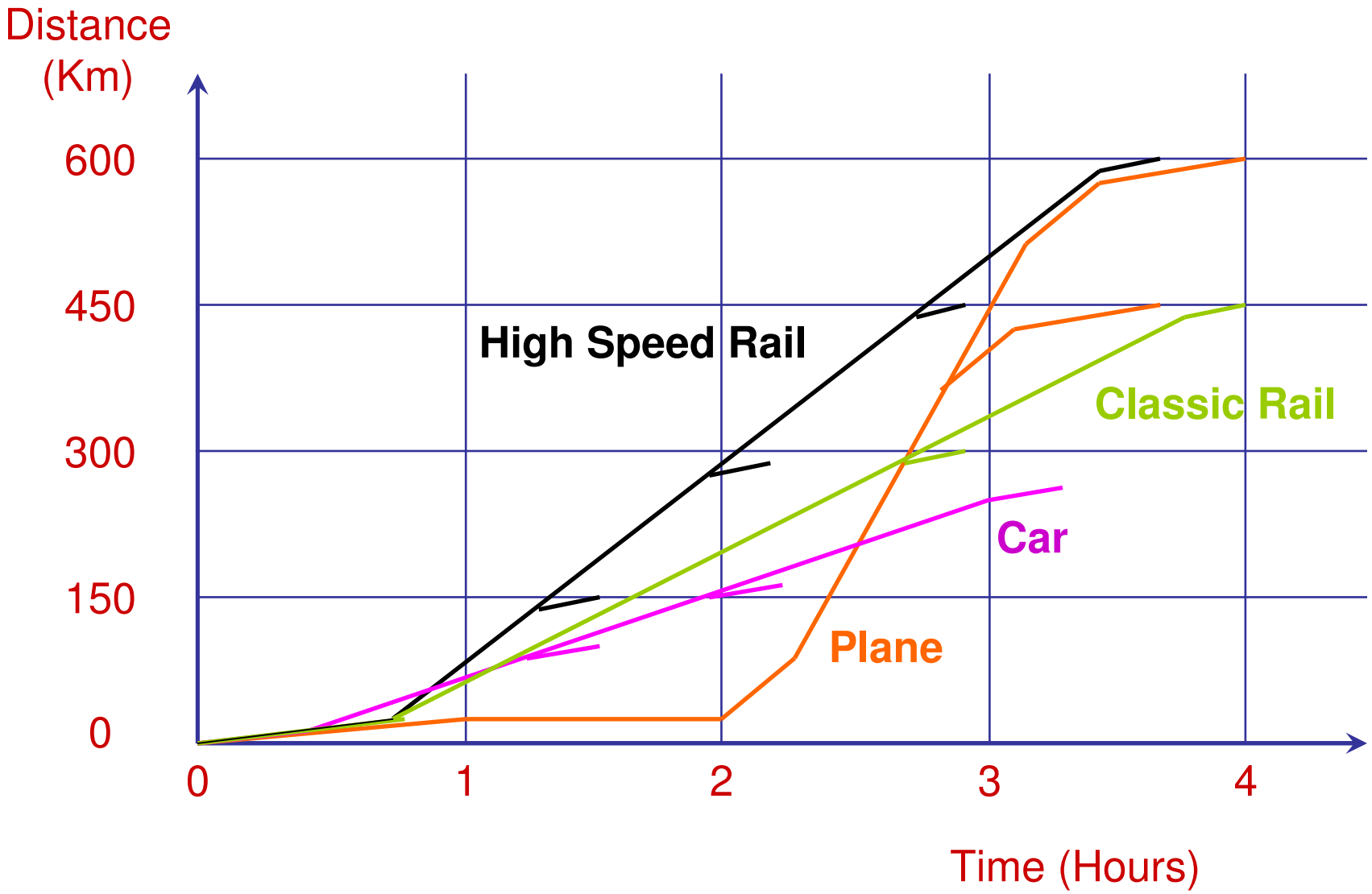
We Have Upgraded Classic Rail

- Dominant mode for travel to Central London
- Growing fast
- Market share between other cities very low
- At maximum capacity by 2025
- Further upgrading extremely disruptive

Door to Door Journey Time

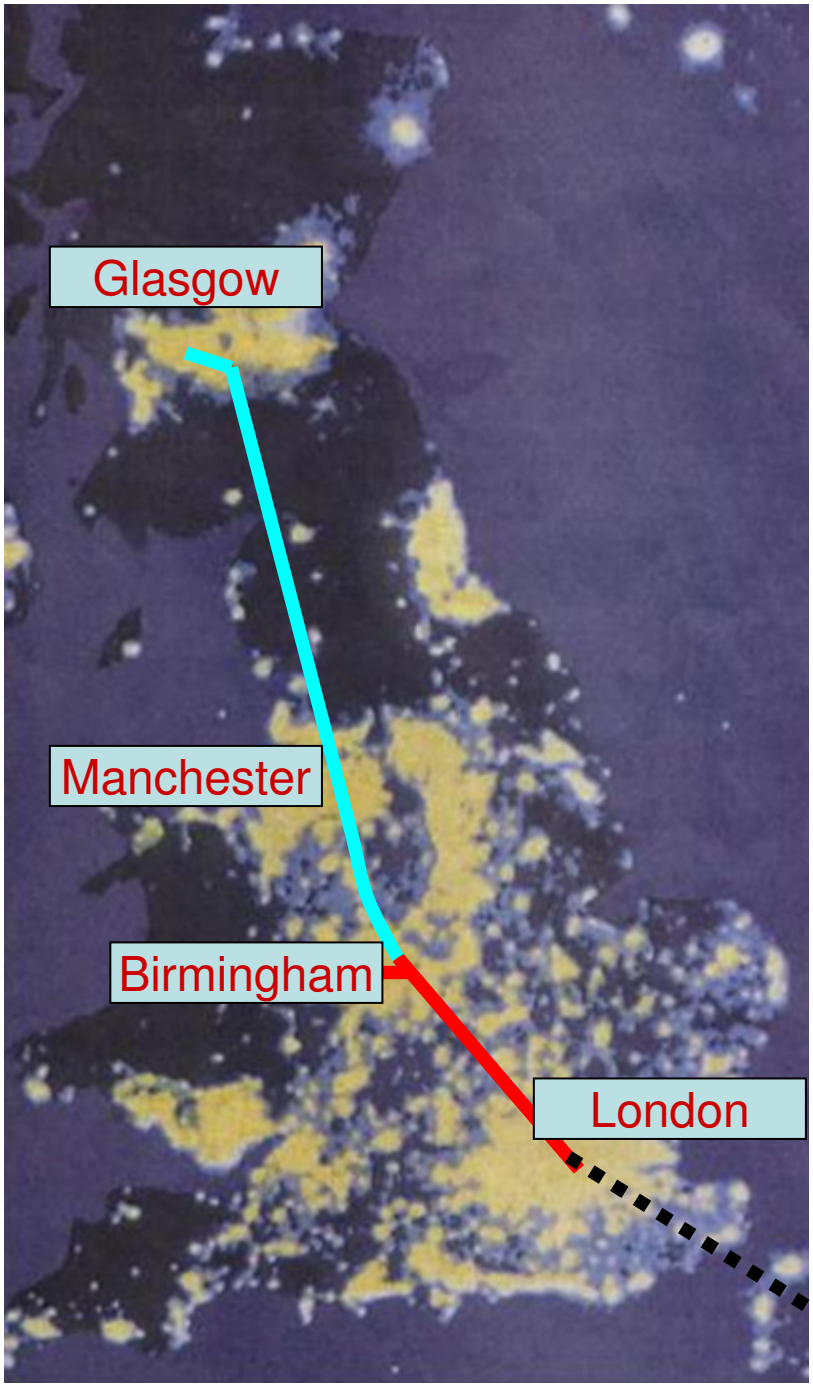


Door to Door Journey Time



Initial Network

- London to
  - West Midlands 1-24 to 0-49
  - Manchester 2-08 to 1-13
  - Leeds 2-15 to 1-20
  - Scotland 4-20 to 3-30
- Birmingham to
  - Manchester 1-34 to 0-40
  - Leeds 2-05 to 1-00
- Heathrow to
  - Manchester 1-10
  - Paris 2-40



1st Stage

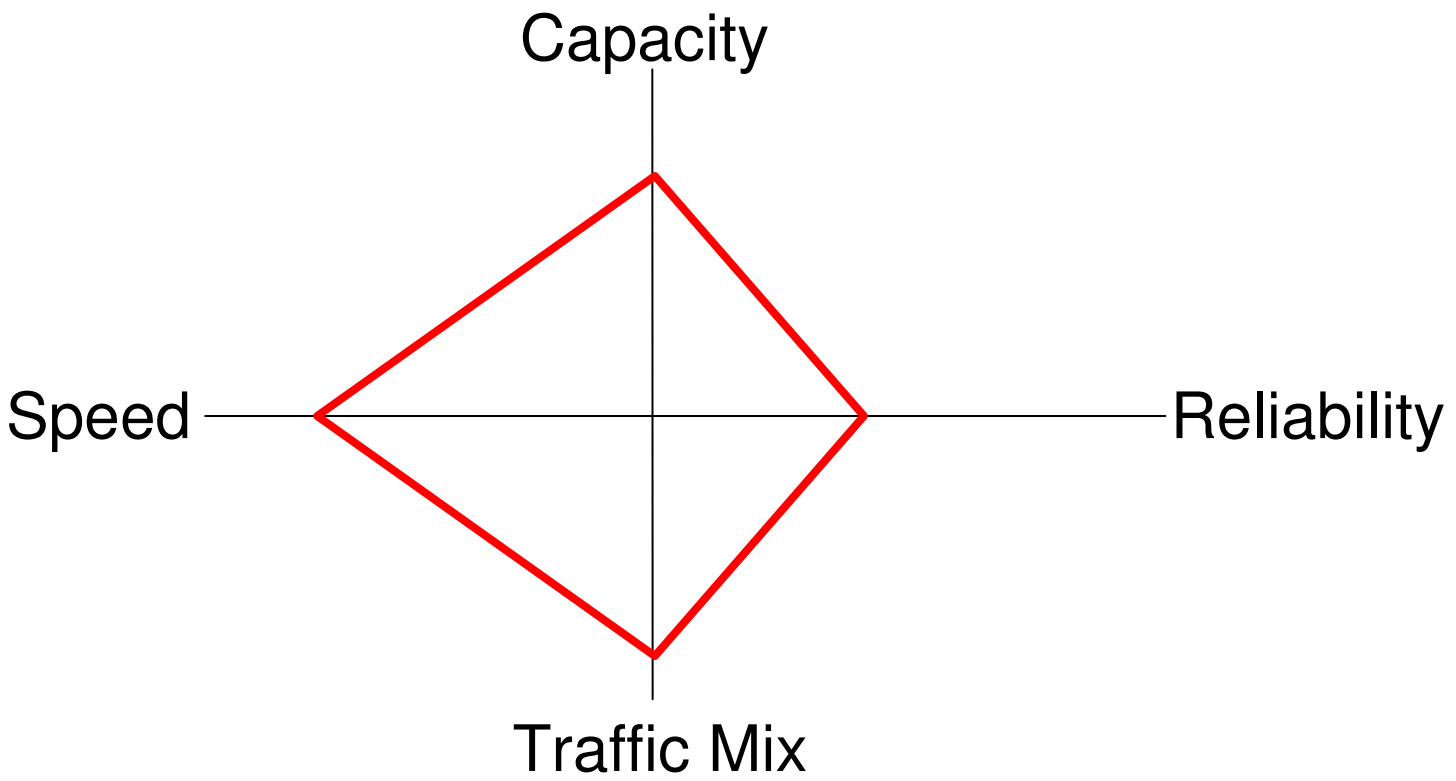
- London to
  - West Midlands 1-24 to 0-49
  - Manchester 2-08 to 1-40
  - Glasgow 4-20 to 4-00
- Birmingham to
  - Paris 4-30 to 3-00

Through Running – “Eurostar Mark 2”

High Speed Specification

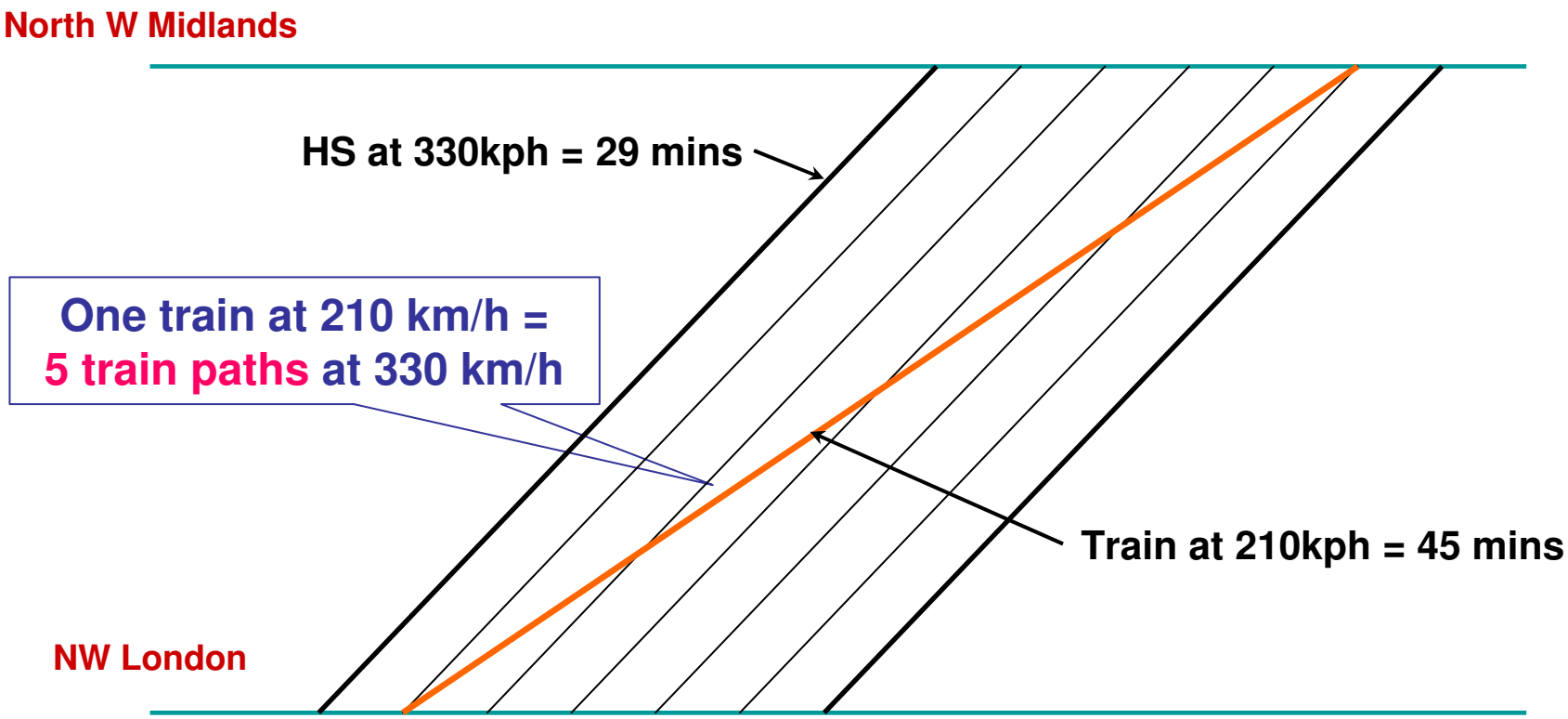
- No premium on fares
- Journey times based on 360kph (225mph) trains
- Up to 18 trains per hour
- Fully EU TSI Compliant
- Up to 1100 seats per train

Maximising Capacity *and* Speed



(speed / performance / stopping pattern)

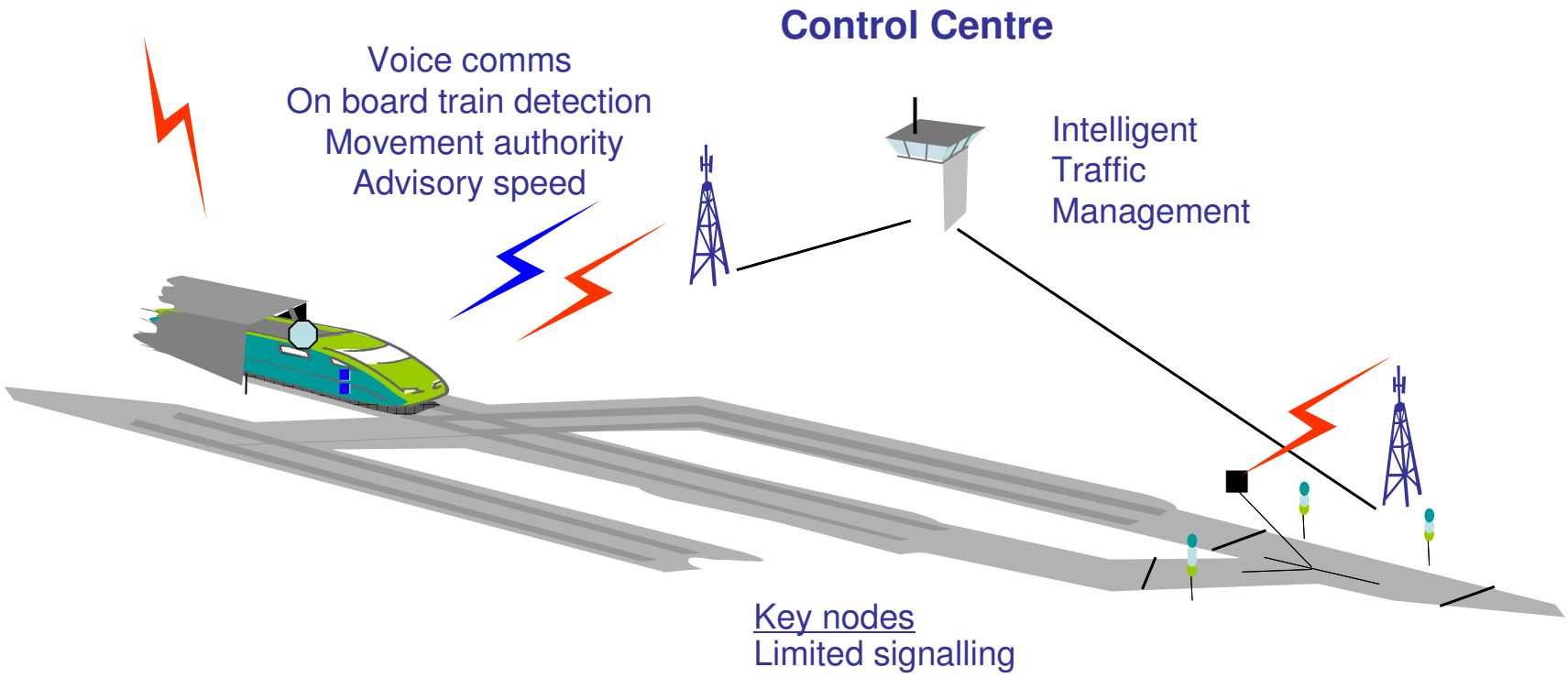
Avoiding Mixed Traffic



Alstom AGV – 3rd Generation Train

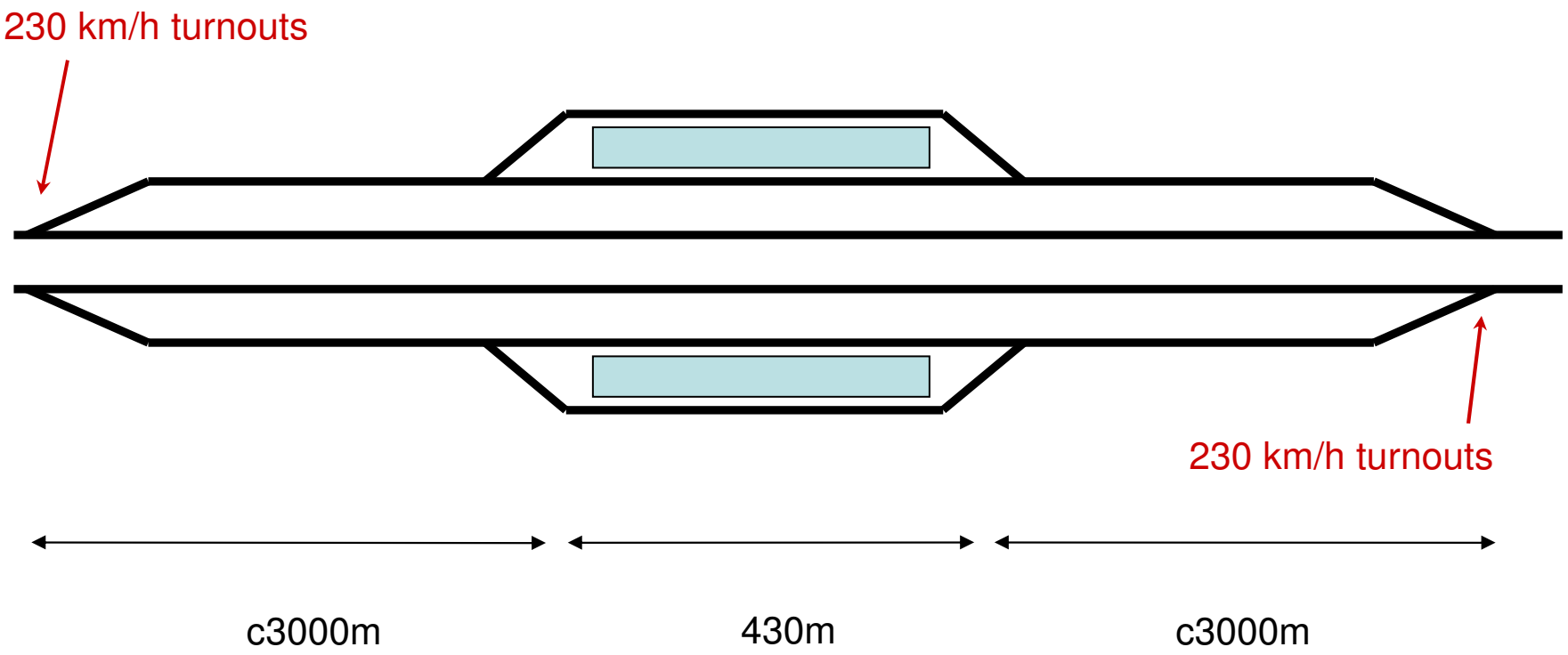
Entering Service 2012

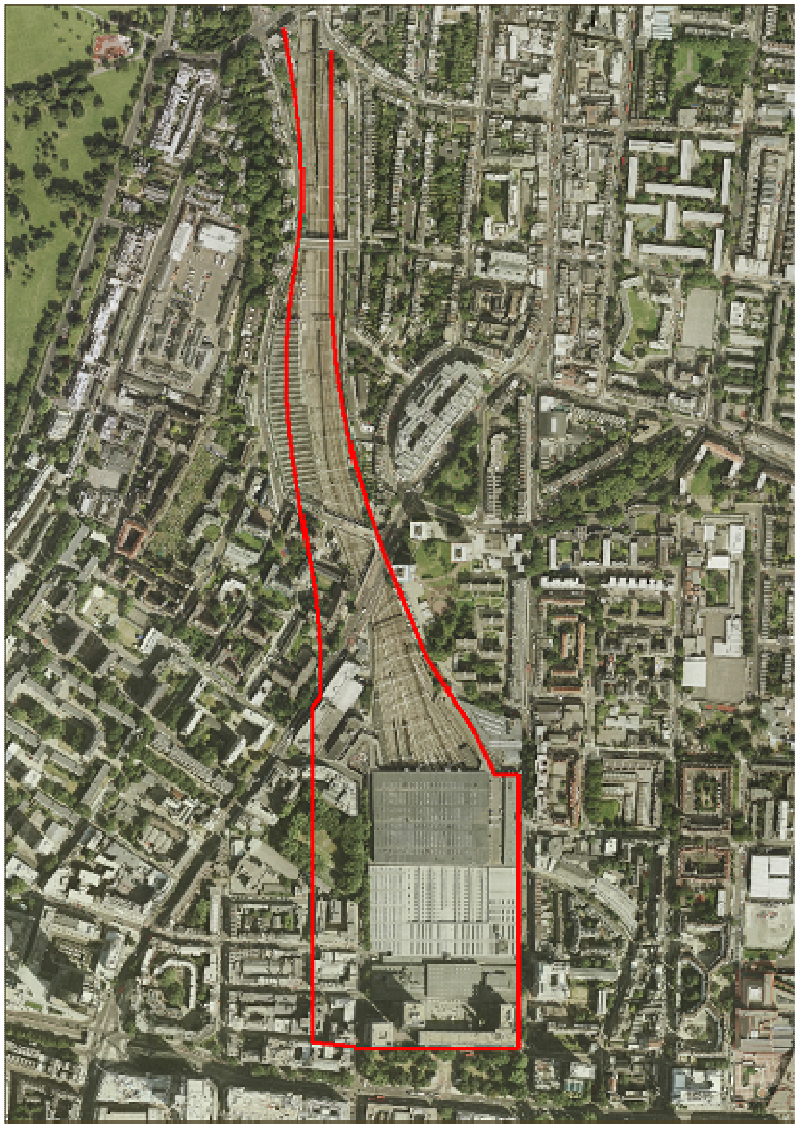
ETCS Level 2


Control Centre
Voice comms
On board train detection
Movement authority
Advisory speed
Intelligent
Traffic
Management
Key nodes
Limited signalling

Radio Bearer Challenges

Simple Intermediate Station





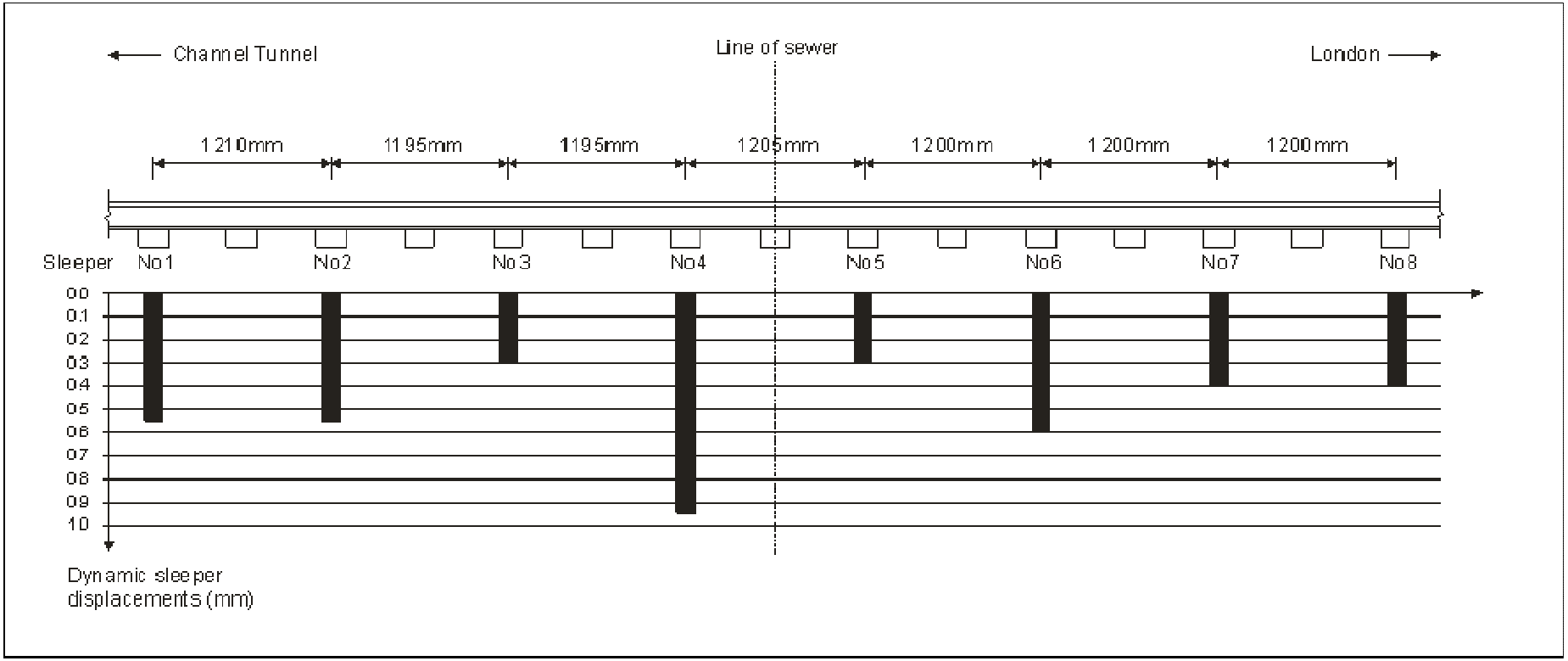
Efficient Operation

- Roll-in Roll-out at Old Oak Common Etc
- Countdown departure
- Acceleration / Braking from / to the buffer stops
- 20 minute turnaround
- Absolute reliability

Automatic Train Operation

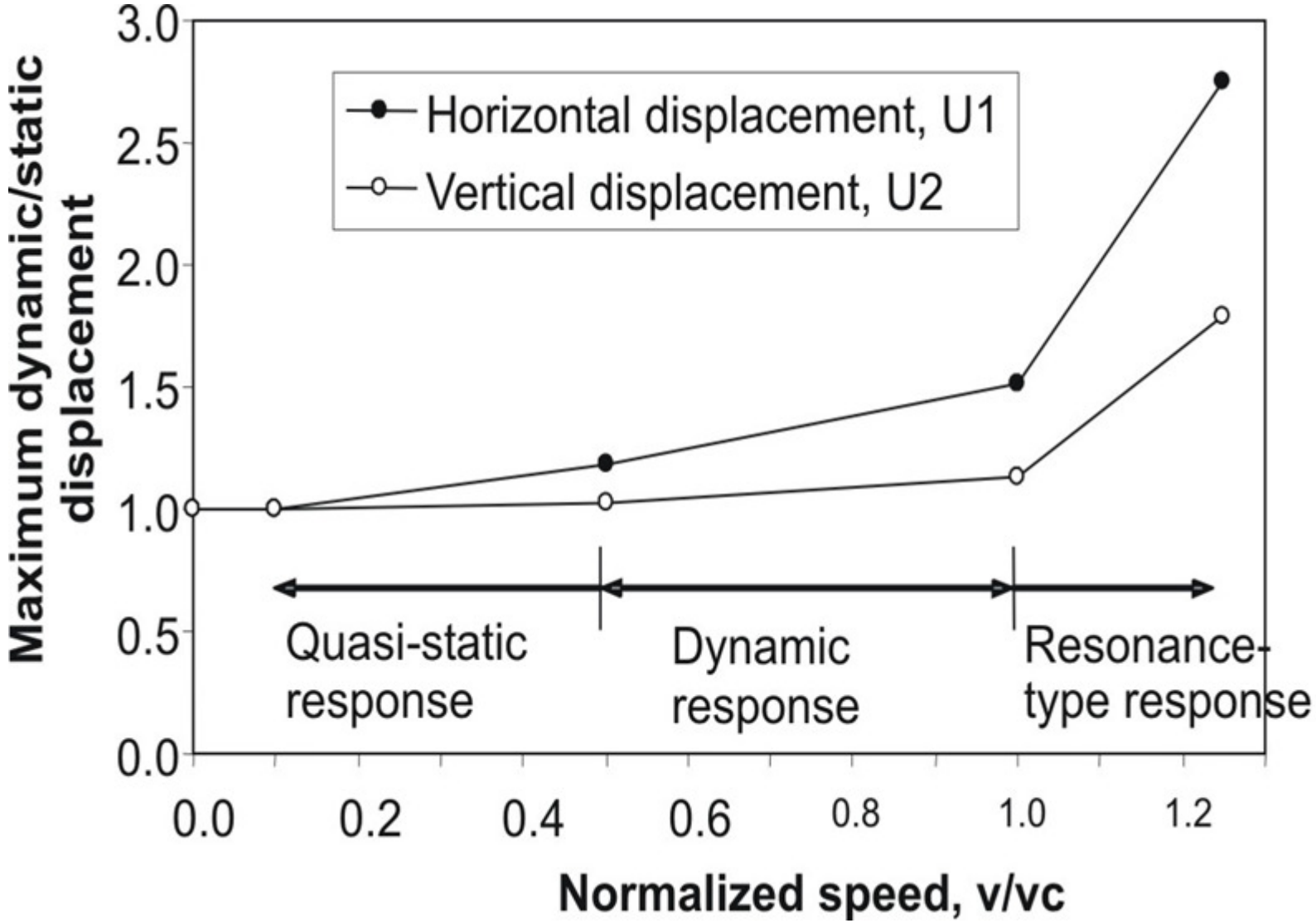
Re-think Ballasted Track?

Variable Ballast Compaction

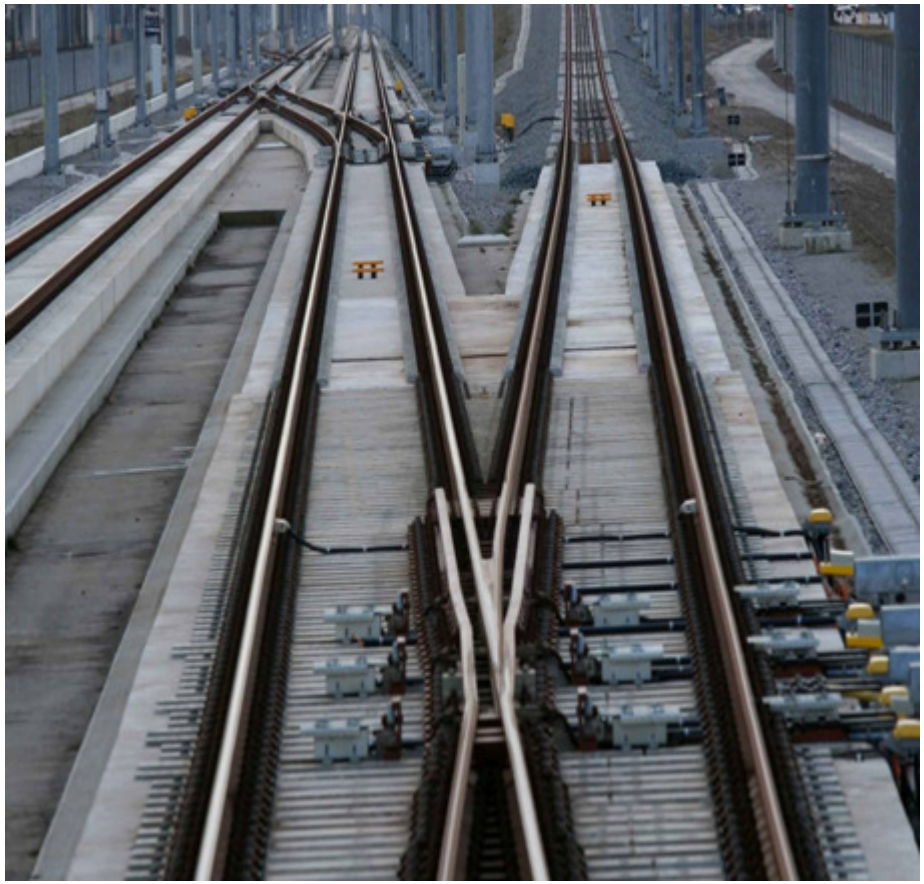


Differing displacements under new track on High Speed 1

Variation of Displacement with Speed

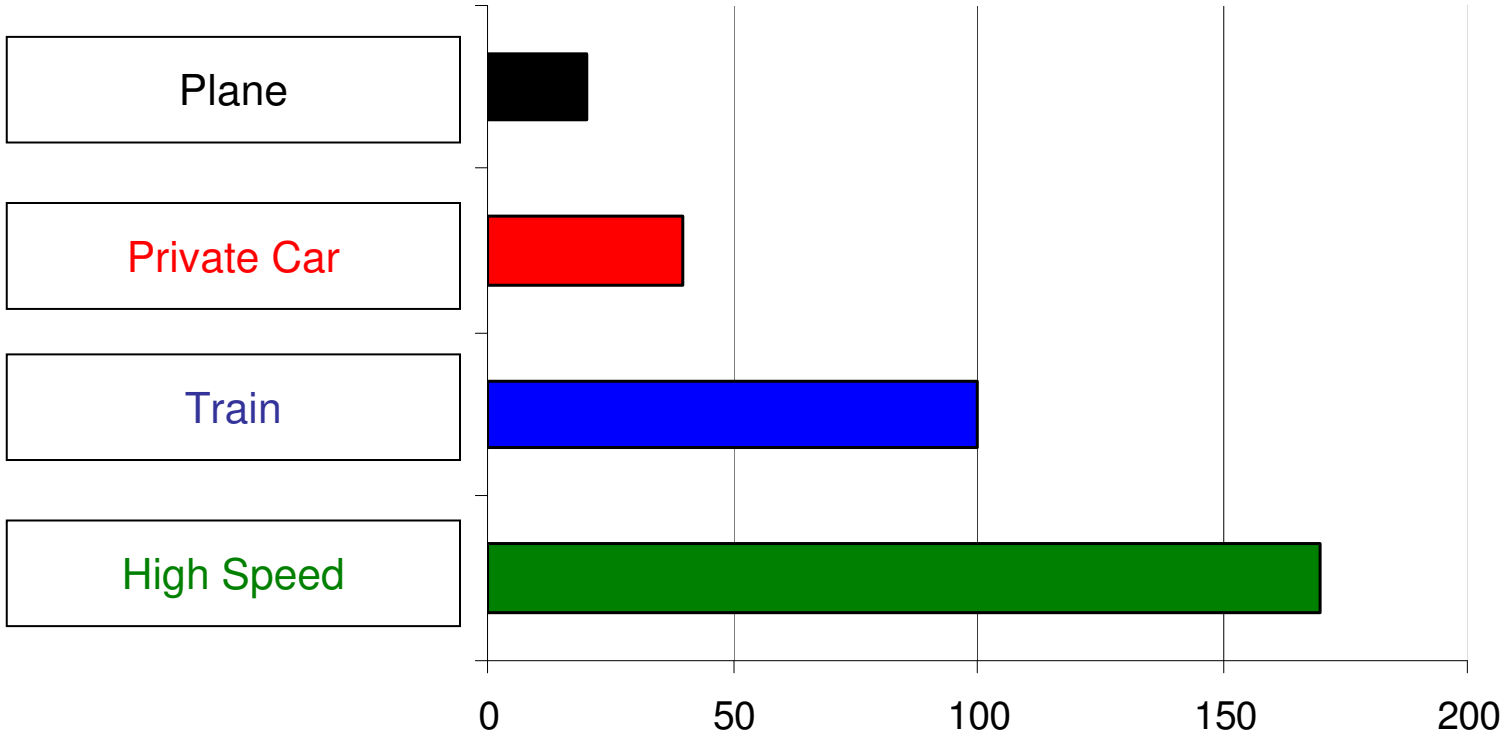


Continuous Slab Track Form?



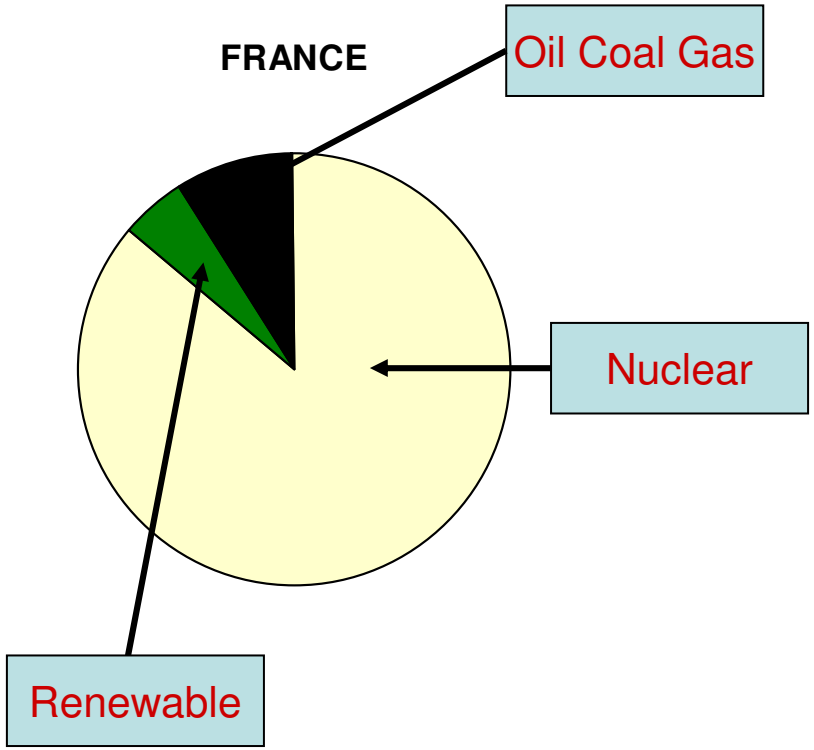
Automated Examination

Energy Efficiency

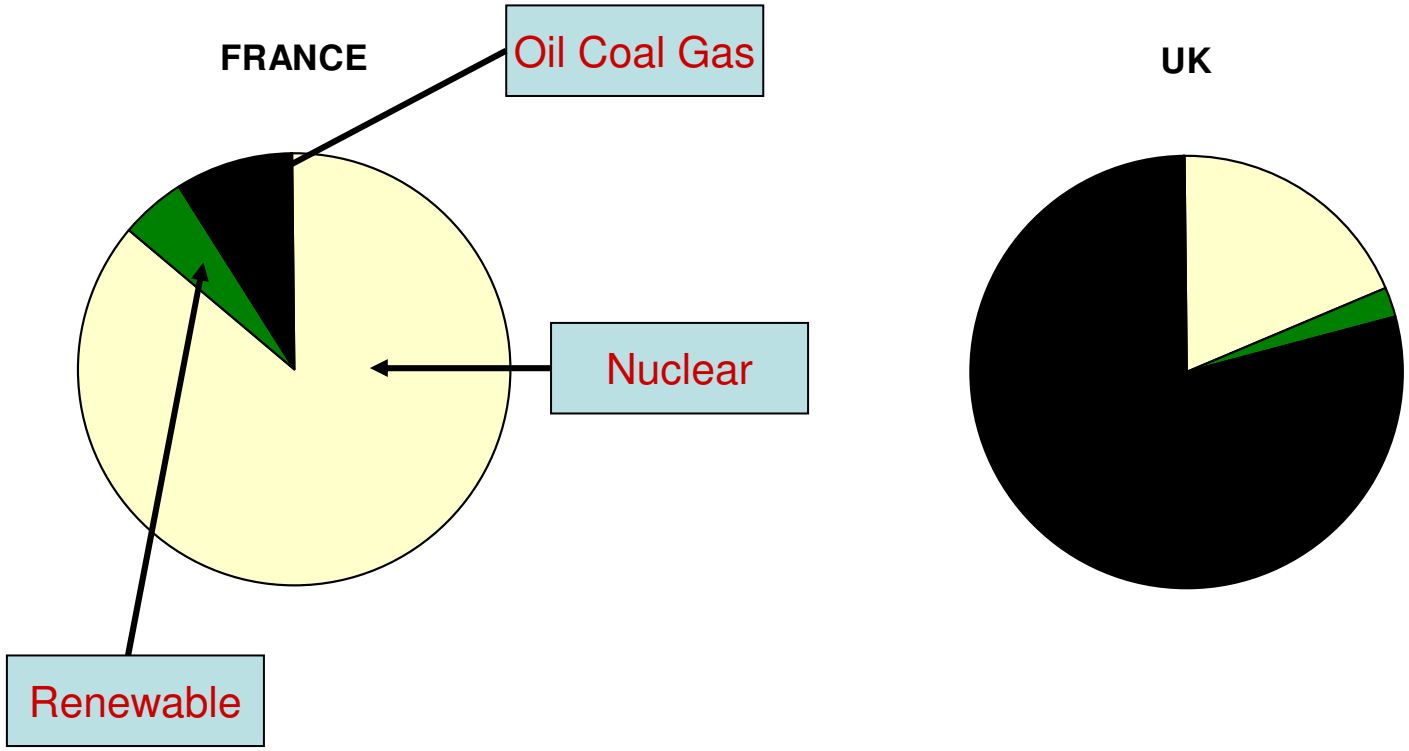


Passenger km per kilo equivalent petrol

Power Generation Mix

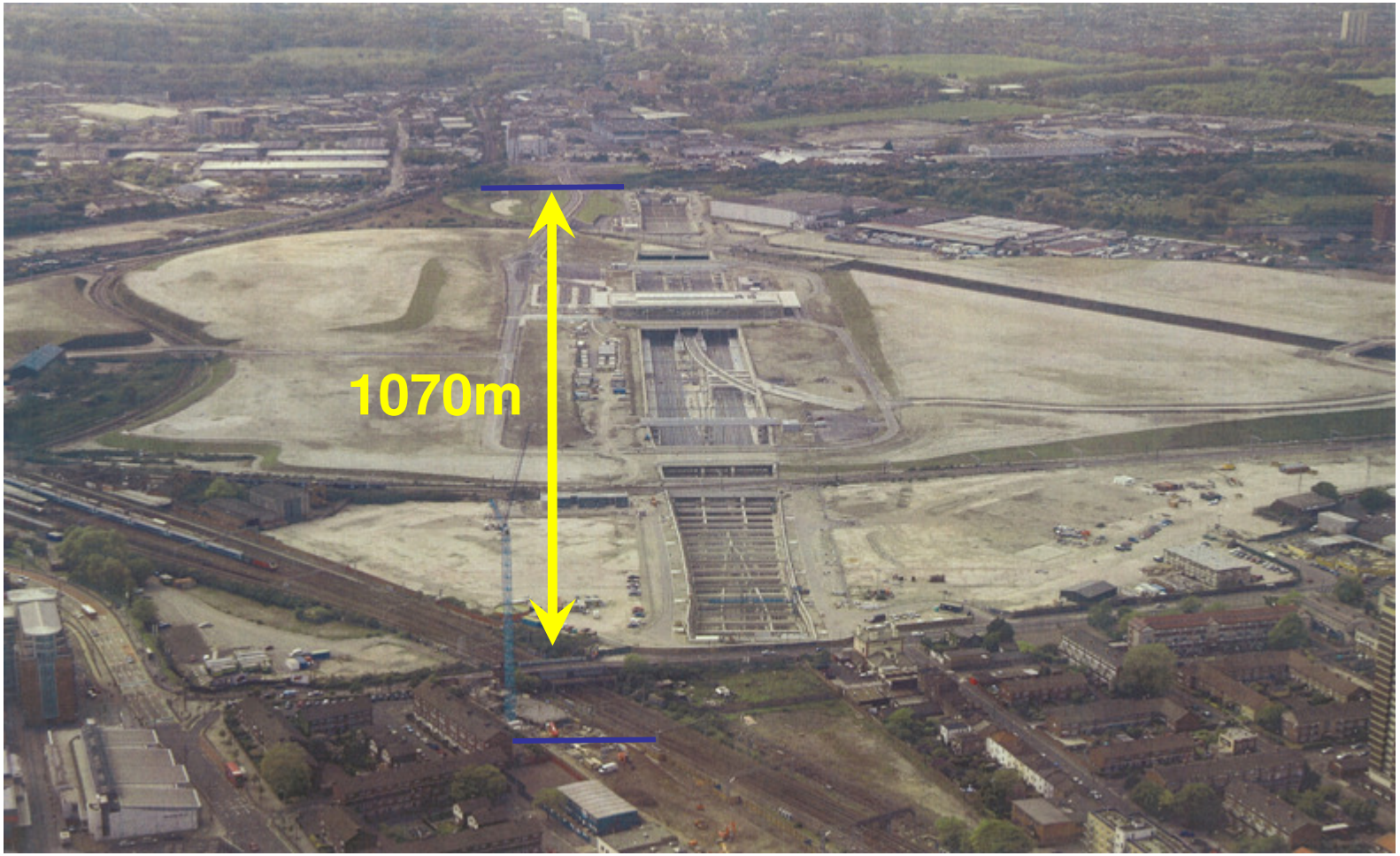


Power Generation Mix

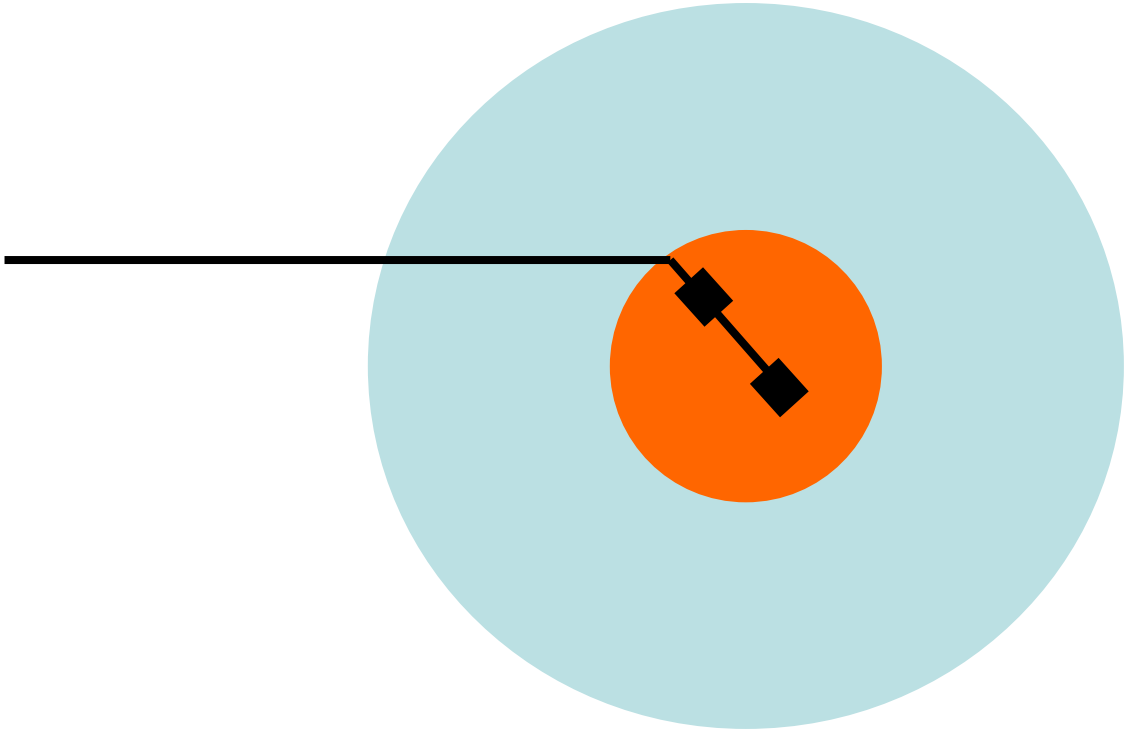


Where To Serve – City or Fringe?

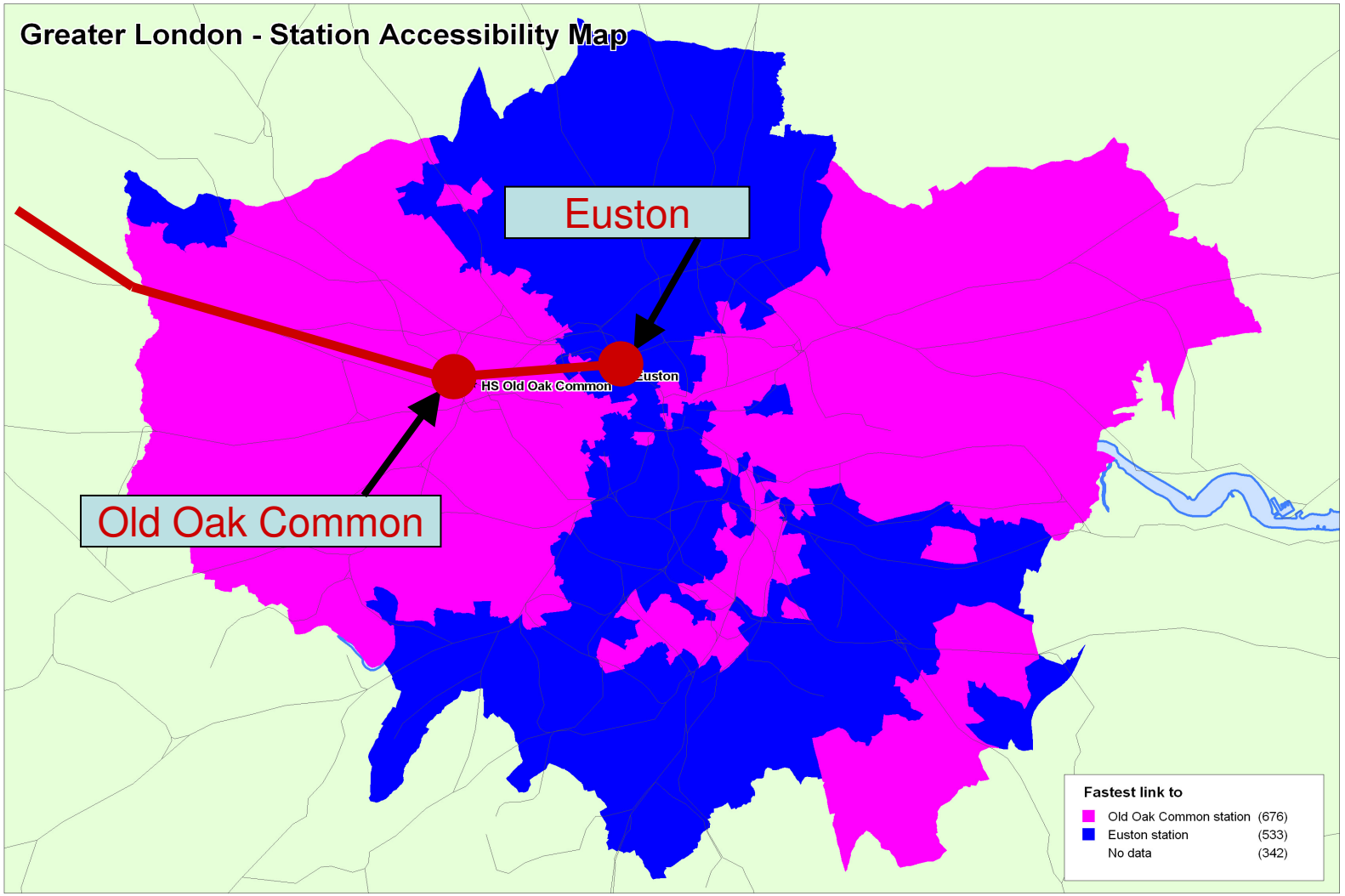
HS Stations are Large!

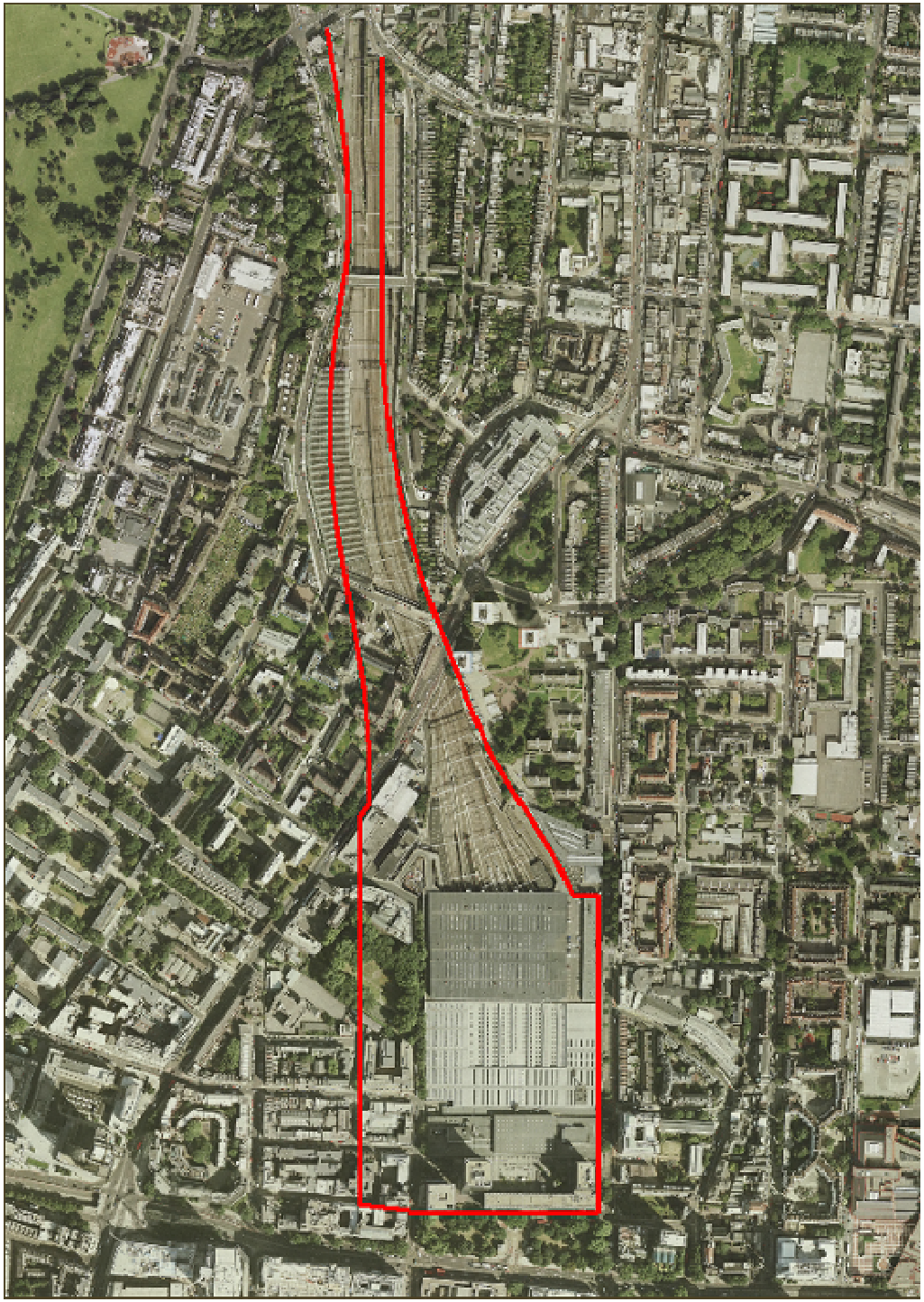


Metropolis A (>~ 5m People)



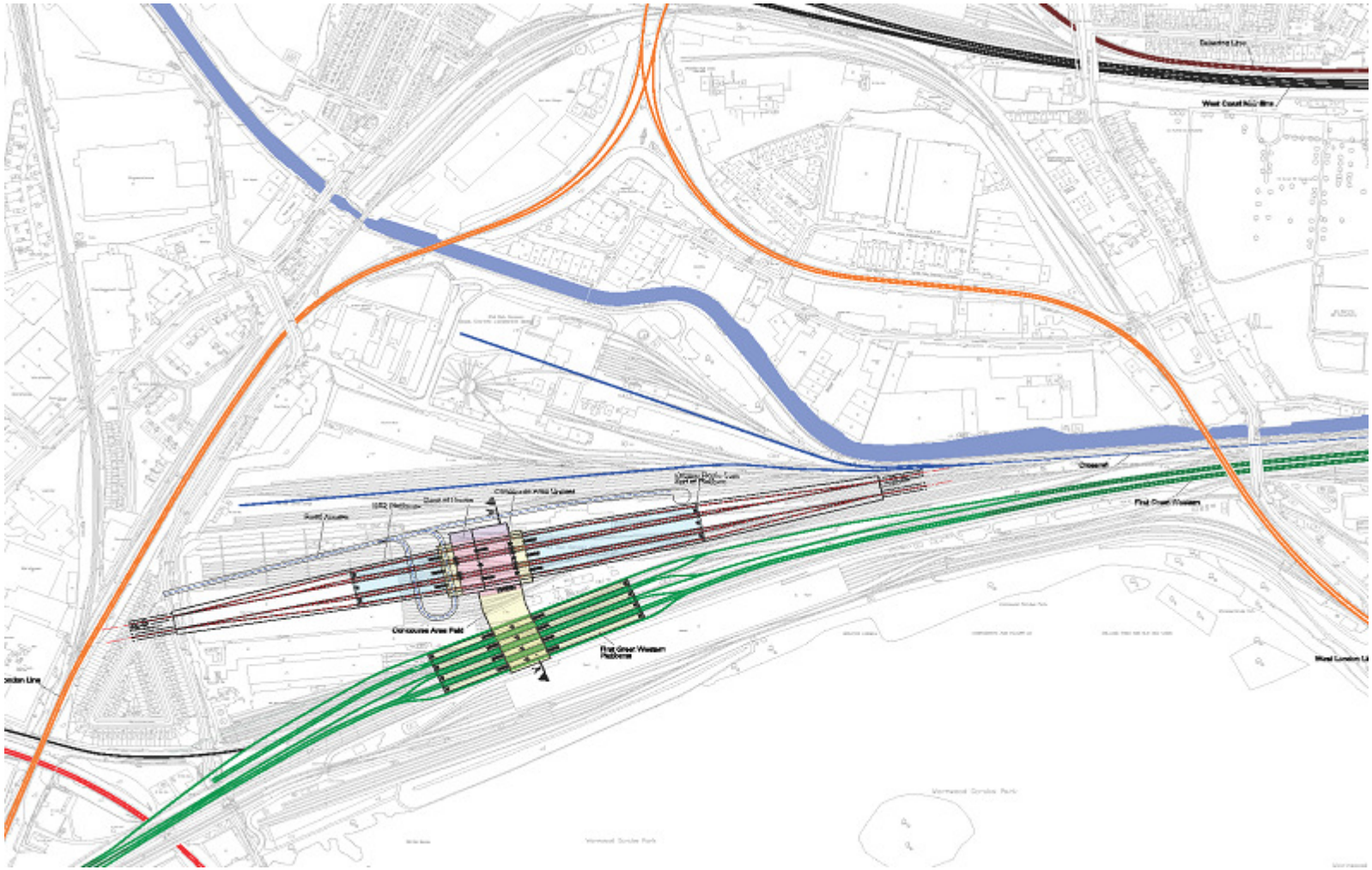
London - 2 Central Stations





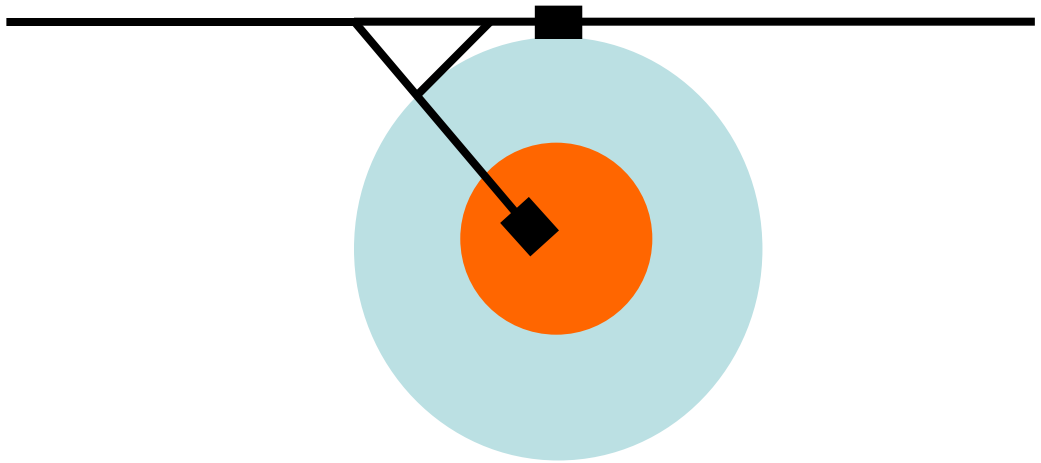
London Euston

Old Oak Common Interchange

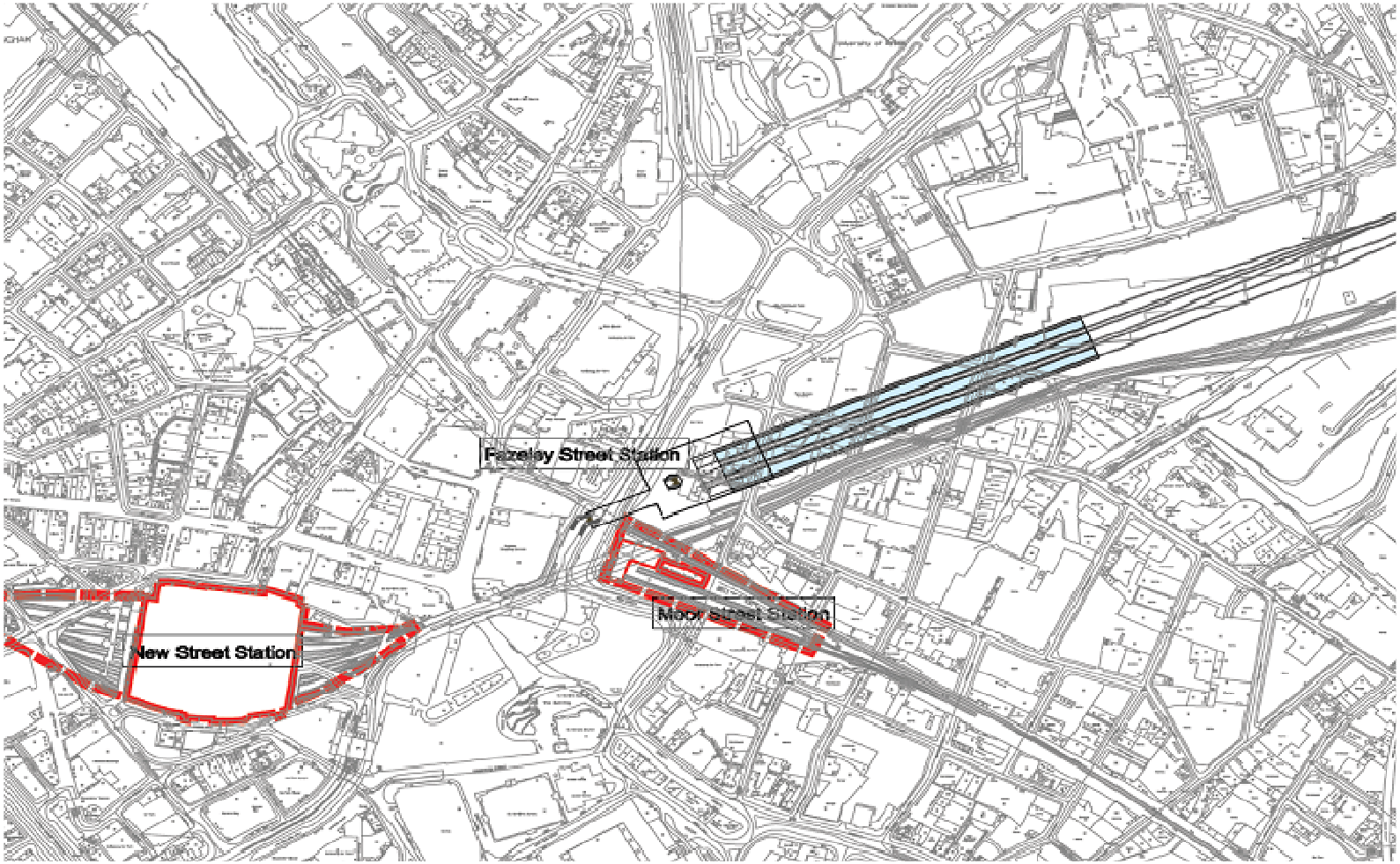


Old Oak Common

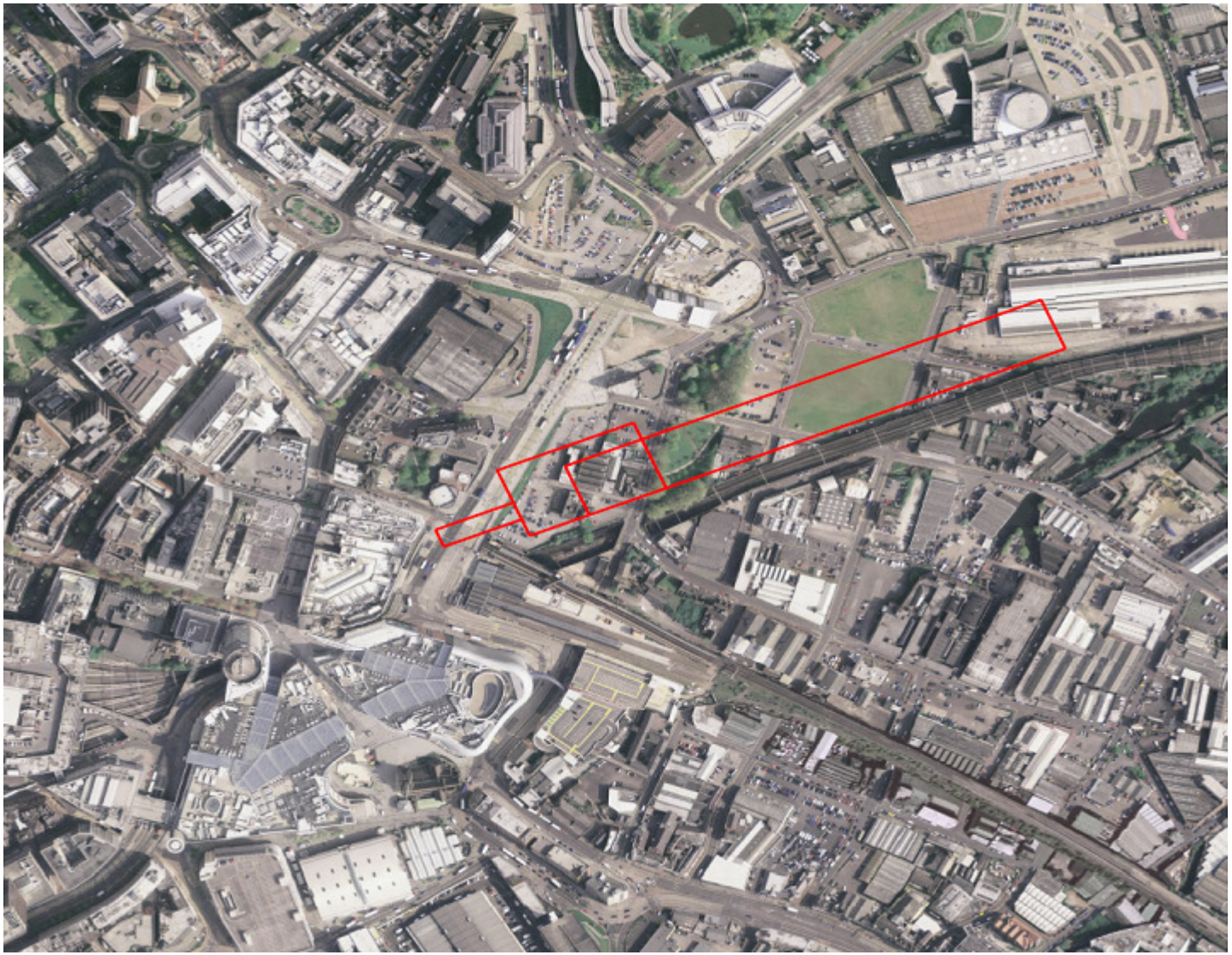
Large City B (~ 3m People)



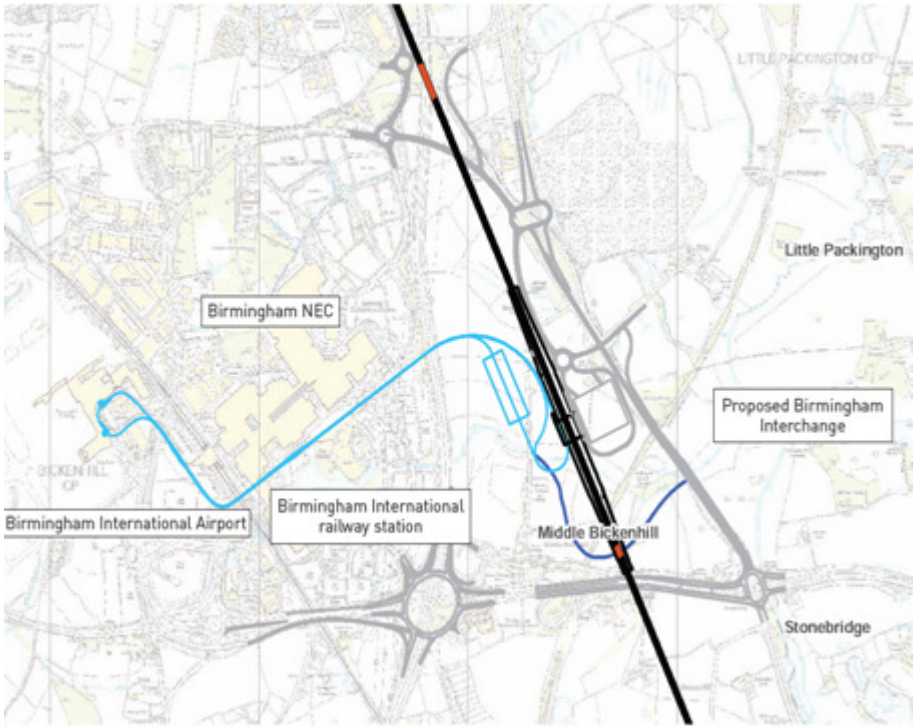
New Central Birmingham Station



New Central Birmingham Station



West Midlands Interchange



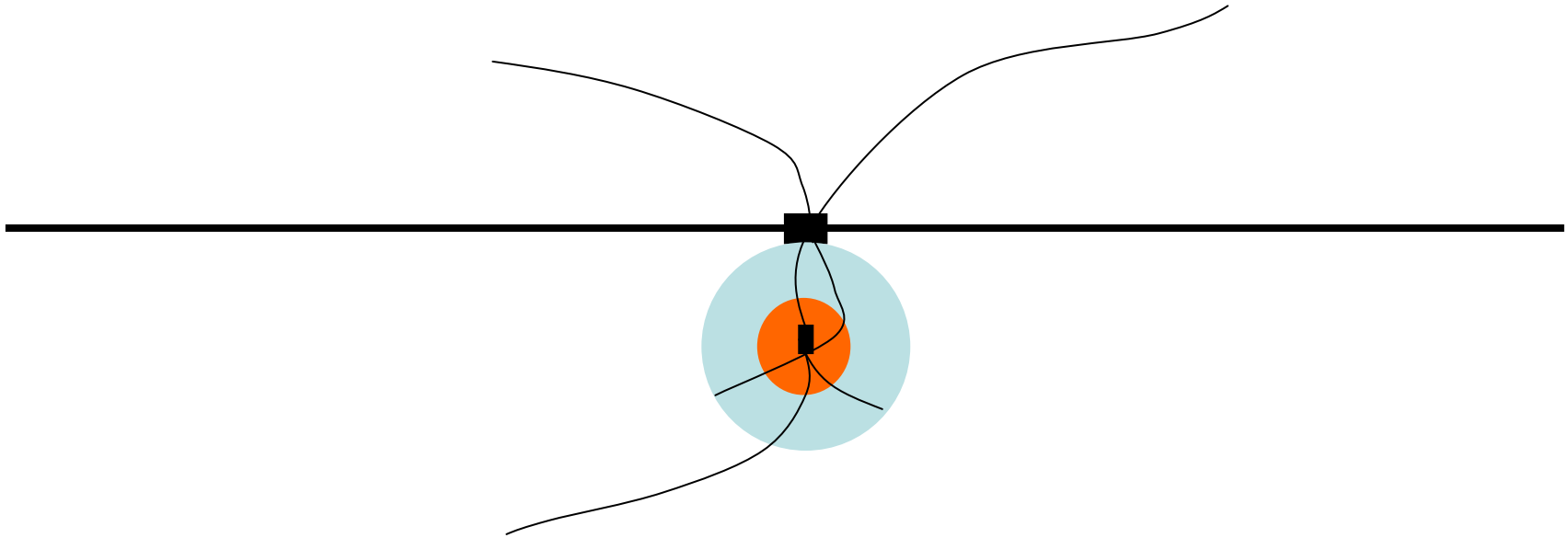
Links to National Exhibition Centre and the Airport

'Parkway' feeder for the metropolitan area

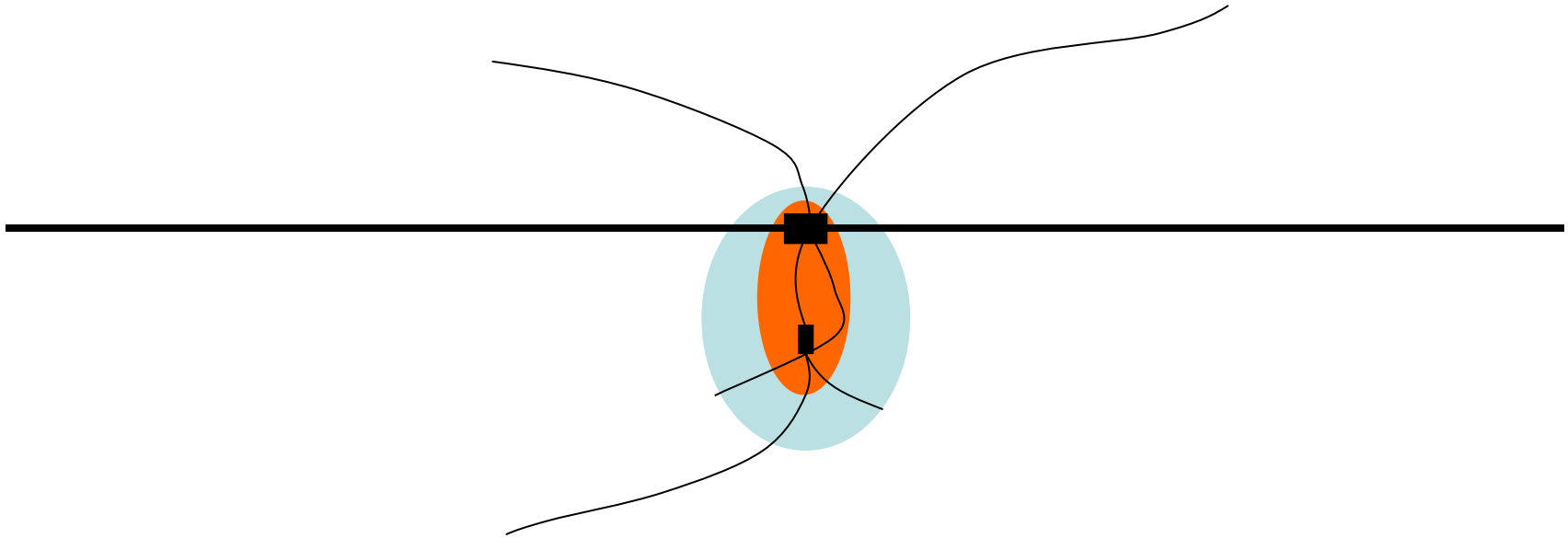
People mover connection to be provided

Road connections to trunk network

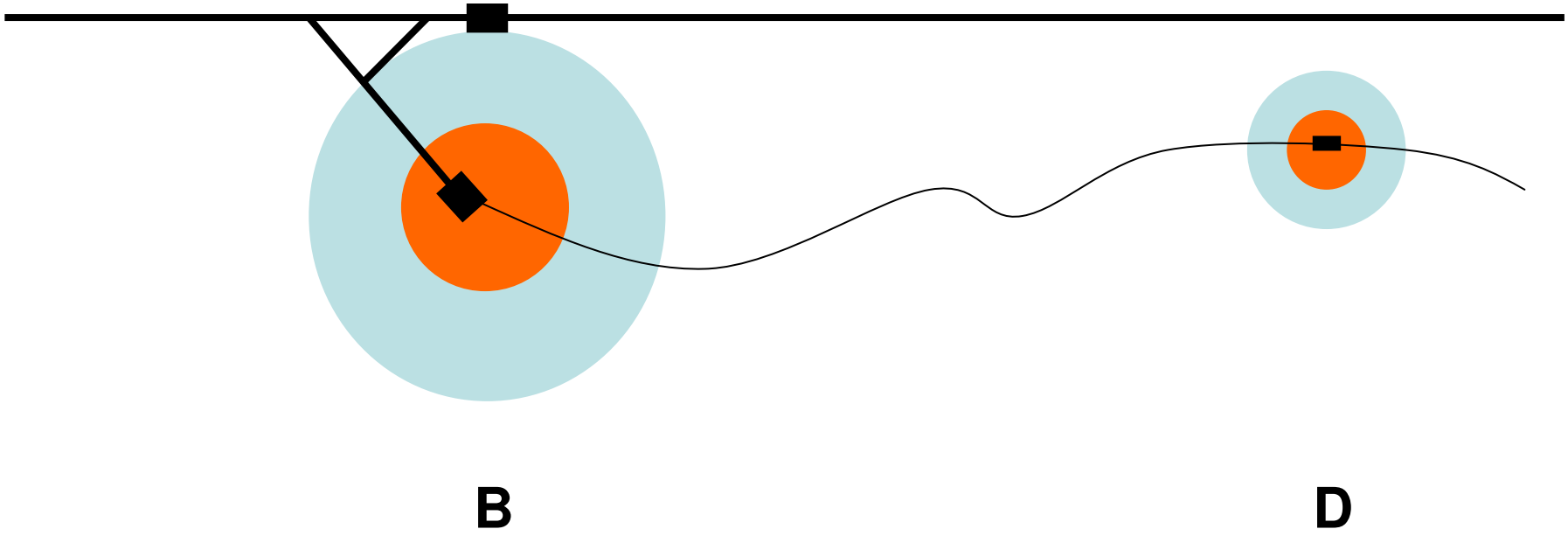
Medium City C (~1-2m People)



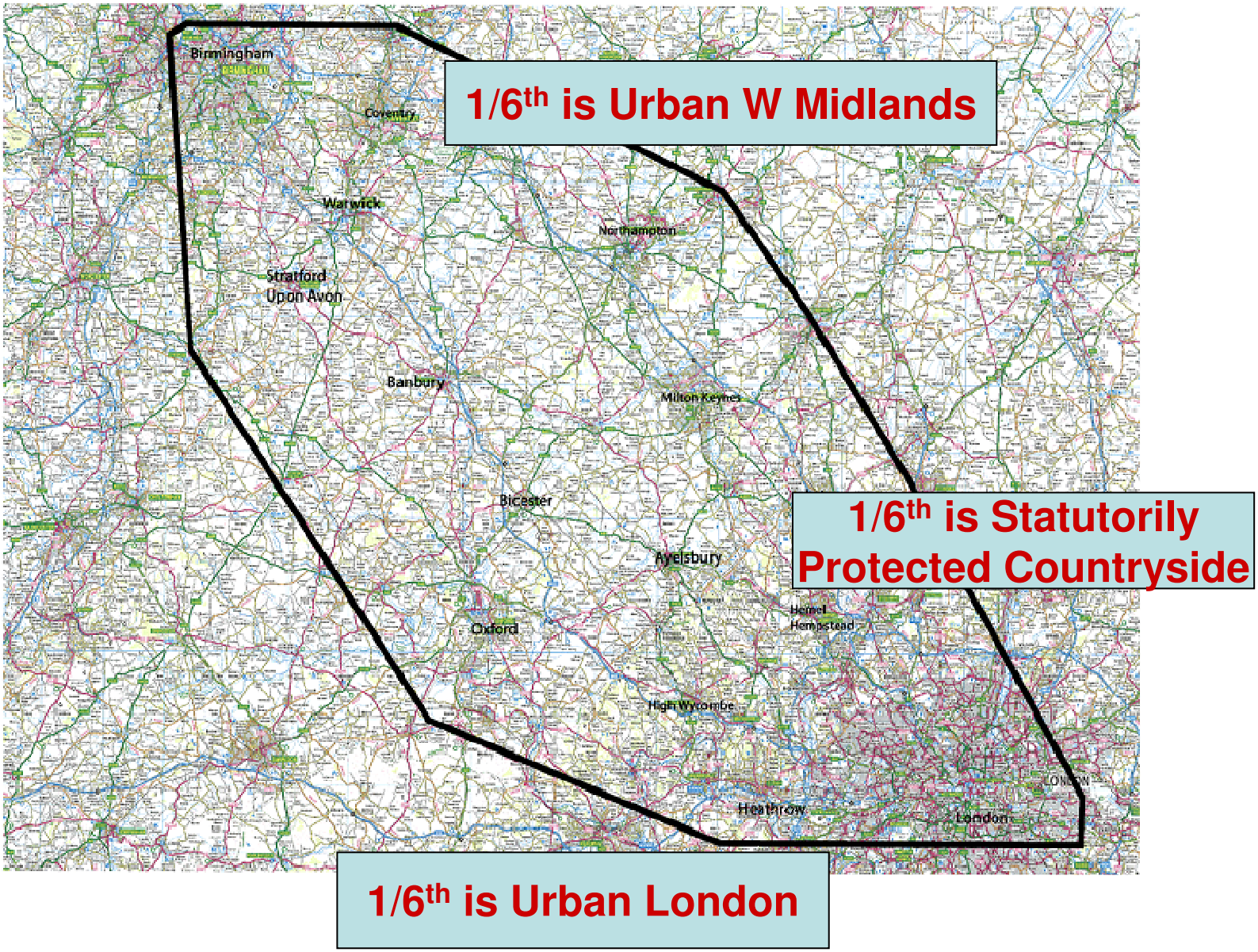
City C Develops to the HS Station



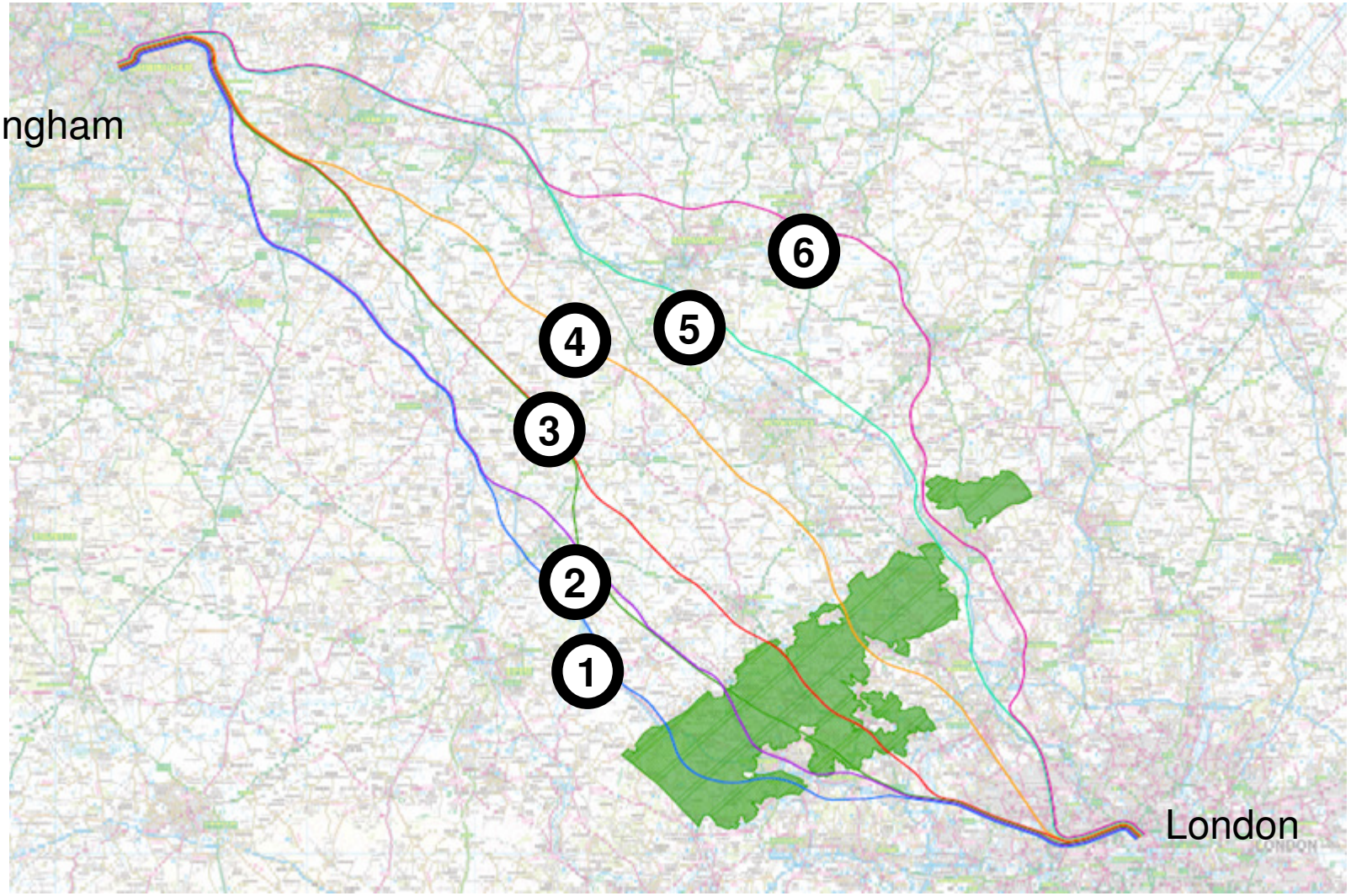
Smaller City D (<~200,000 People)



Route Challenges – Urban and Rural



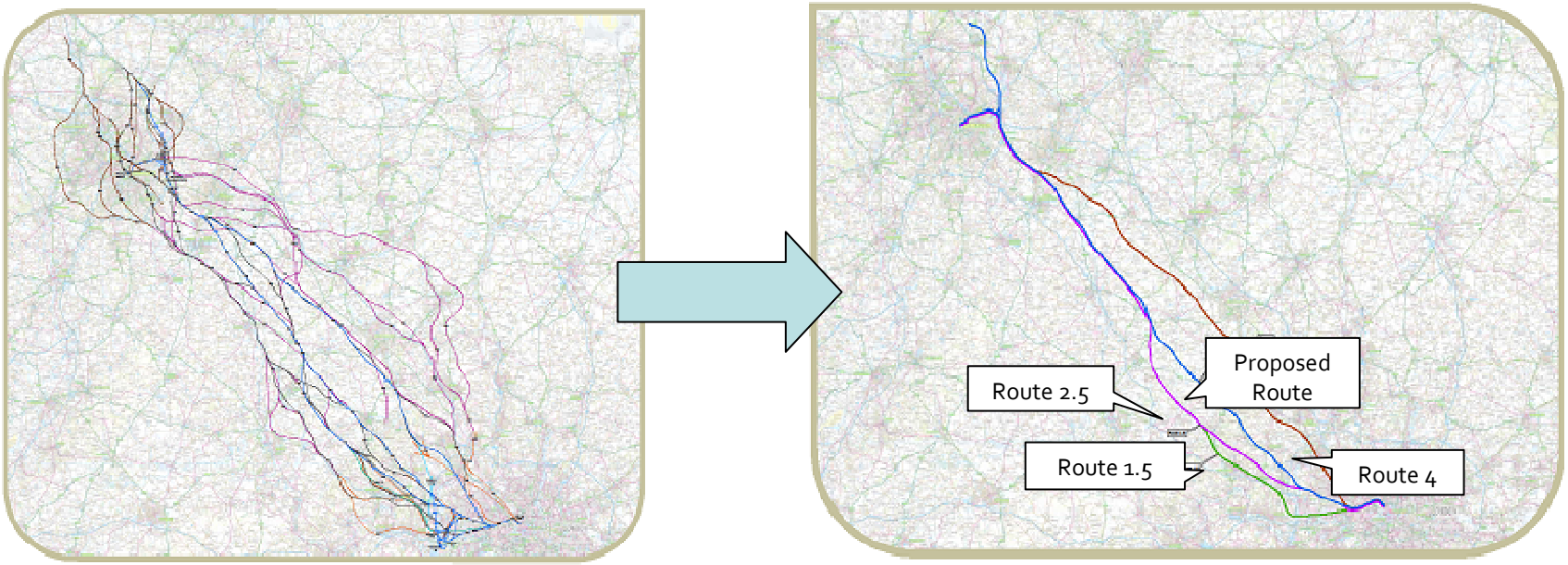
Initial Corridor Thoughts



Follow Existing Transport Corridors?

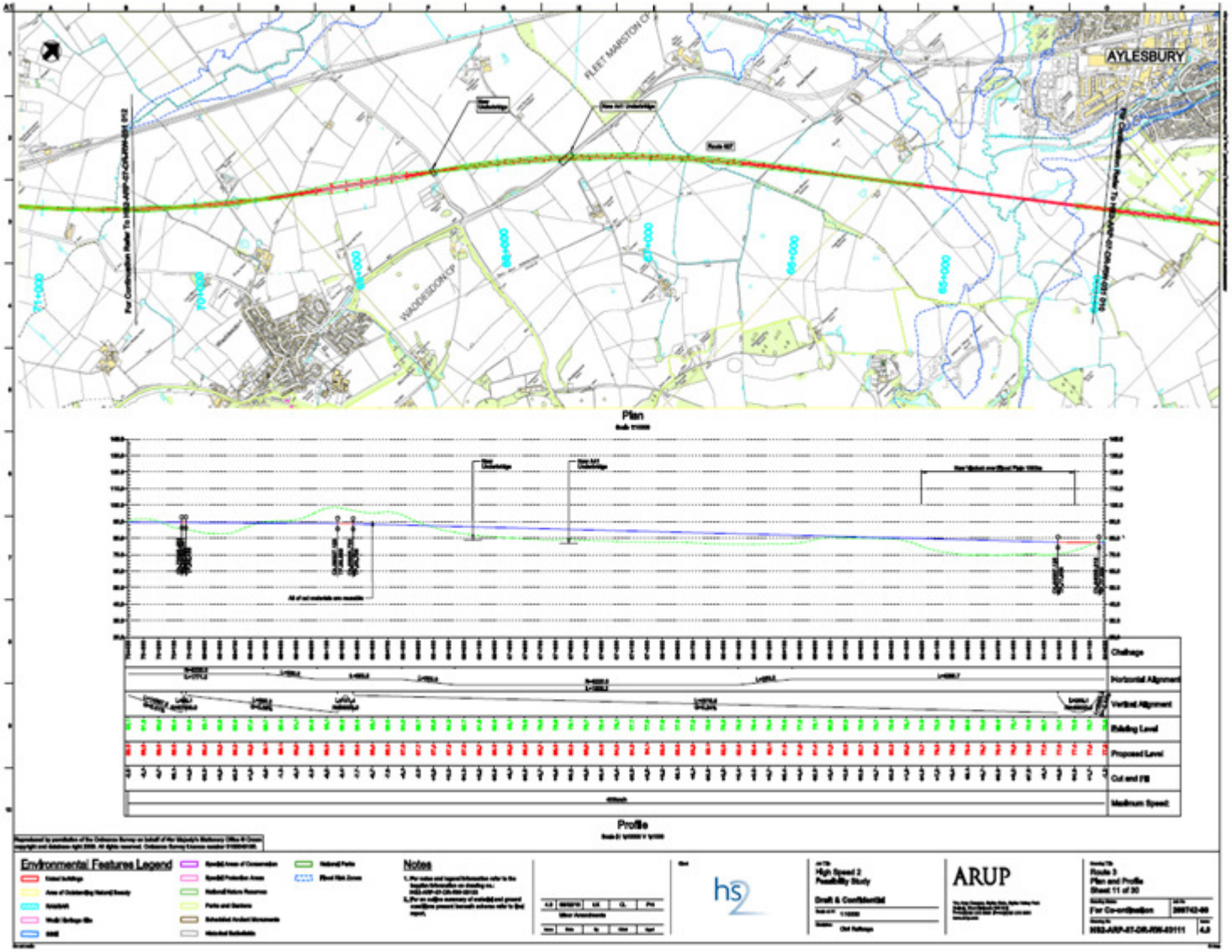
Route Selection Process

Balancing Sustainability Effects, Cost and Journey Time



In terms of sustainability, the proposed route performed as well as the main alternative while giving the shortest journey times.

A Route not Lines on a Map



Southern Britain is Densely Populated


Wendover C. C.
Ellesborough
For
2 miles


40

Feared Impact

Position in Landscape is Key

Gradients

Classic Main Line:

- 0.5 to 1.0%

HS1 Design:

- 2.5%

Max HS line:

- 3.5%

Cut & Cover “Green” Tunnels

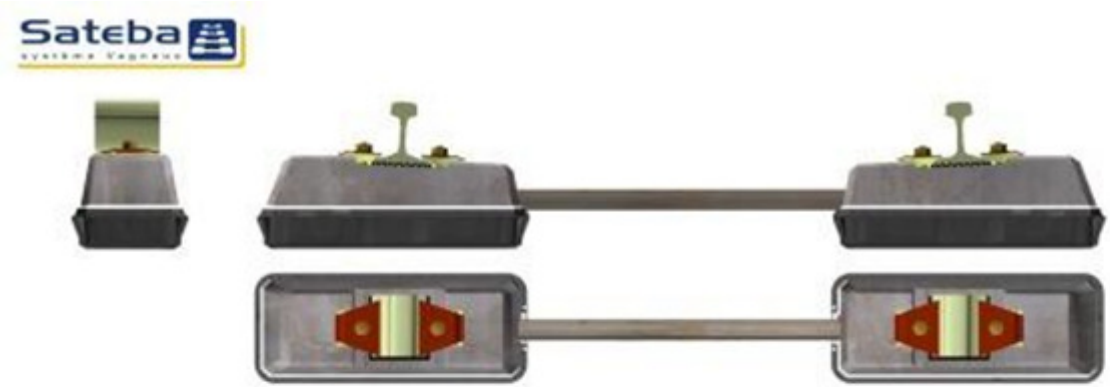
Mitigating Effects on People and Nature

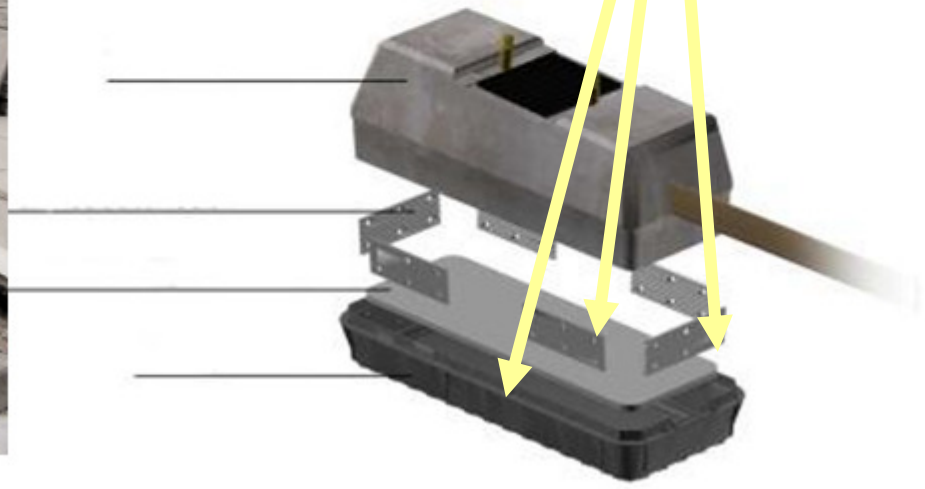
Noise Mitigation : Landscape and Barriers

Images: Arup (HS1)

Bored Tunnels

Tunnel Noise and Vibration Control





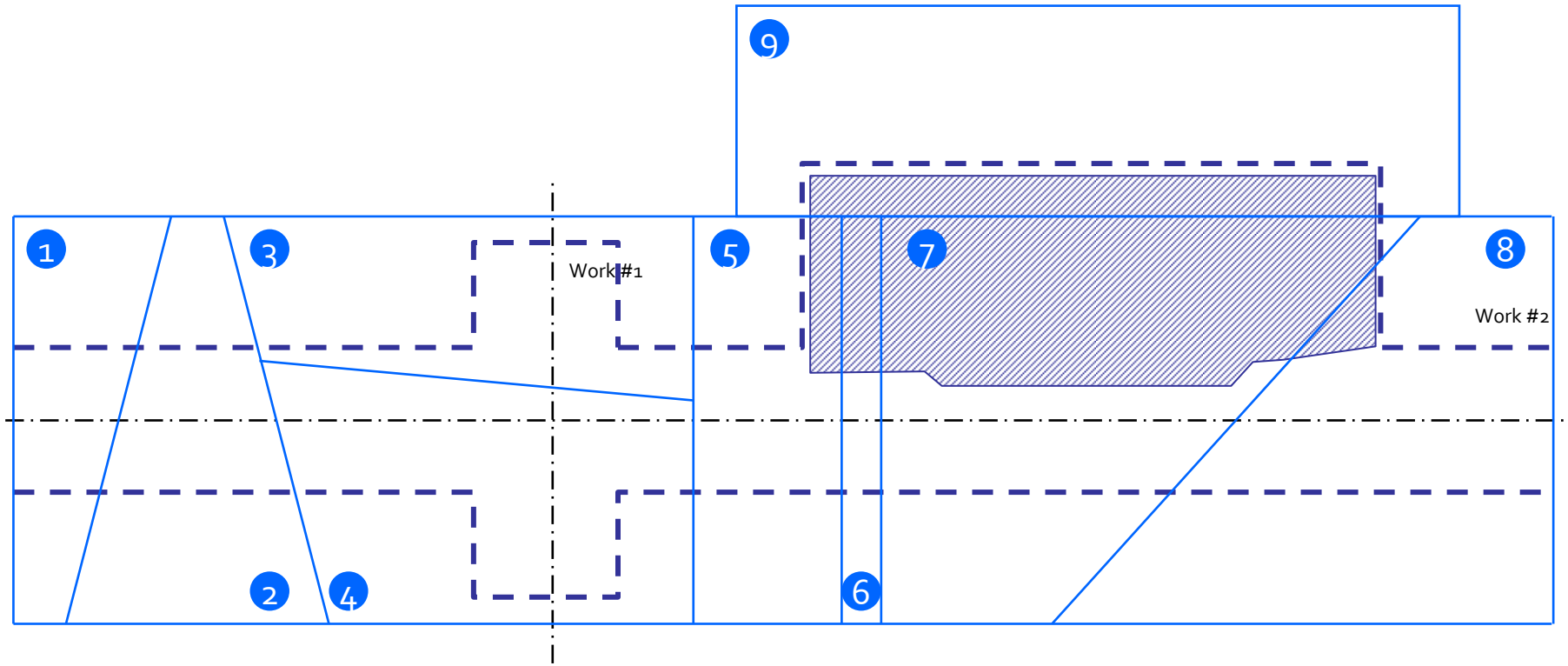
Impact of Viaducts

Typical Low Viaduct

Colne Valley Viaduct

Scandanavian Design?

Land Required Permanently – and Temporarily



Successful Land Reinstatement

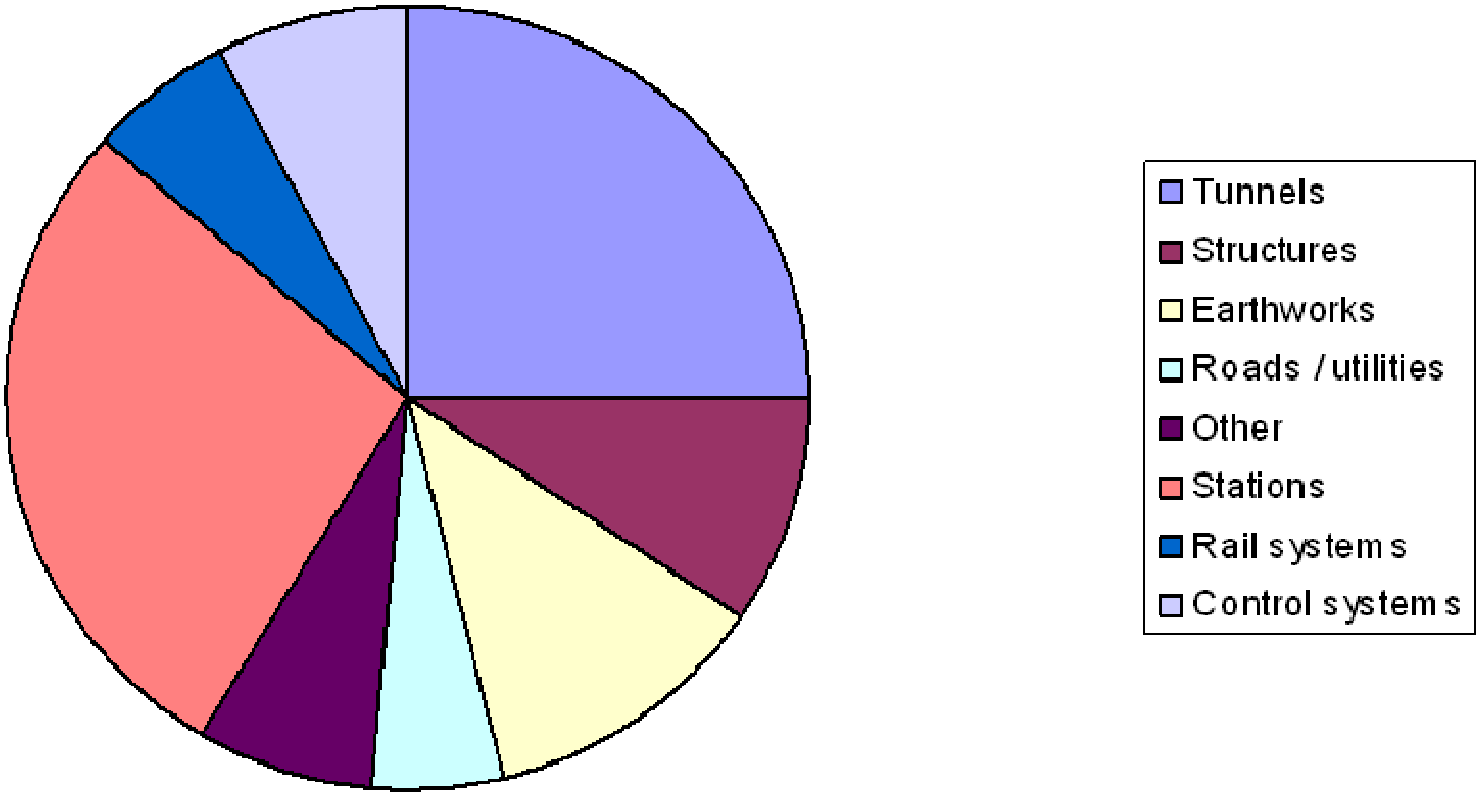
Design Outcomes

Underpinning the Hybrid Bill design:

- Operational concept & analysis
- Physical assets (stations, tracks, motorways, etc)
- Design requirements – local designs for local issues
- Construction plan and methodology
- Environmental Consultation & Impact Assessment
- Final cost estimate and installation programme
- Power Modelling, Installation, Test and Commissioning Programme

- Demonstrating an optimum balance between: Cost; Environmental Impact, Capacity, Journey Times and Performance

London to West Midlands Costs



Cost Structure

Optimism bias	4,165
Construction contingency	2,215
Other (statutory, possession costs)	485
Project management and design	1,035
Depot facilities	500
Land and environment	1,220
Contract management	775
Utility interfaces and rail reconstruction	590
Systemwide	840
Stations	1,675
Civils	2,785

← £16,280m

← £12,115m

£m

HS2 Timescales

- 2011 Public Consultation
- 2012 Decision to Develop
- 2013 Start Act of Parliament
- 2017 Start Physical Work
- 2025 Open to Birmingham
- 2033 The “**Y**” Complete

This is the work of generations

Control System Challenges

- Assume ETCS (European Train Control System) at Level 2 at opening
  - Capability in terminal areas
  - Version 3.0
- Automatic Train Operation desirable but not essential
- Will Chinese TCS be the solution?

Radio Bearer Challenges

- Current standard is GSM-R (essentially “2G”)
  - Capability in urban areas?
  - How long can circuit switched data transmission credibly continue?

- What will commercial communications technology be by 2025?
  - GPRS (2.5G)?
  - EDGE (2.75G)?
  - UMTS (3G) with IP?
  - LTE and Advanced LTE (4G)